



**CIVIL RESERVE AIR FLEET (CRAF): A  
PARTICIPATION ANALYSIS 1986-2005**

GRADUATE RESEARCH PROJECT

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**Wright-Patterson Air Force Base, Ohio**

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## **Abstract**

Since deregulation, the Civil Reserve Air Fleet (CRAF) has undergone significant commitment fluctuations within its long-range international passenger, cargo, and Aero-medical segments. Some of the causes of these fluctuations include the cyclical economic cycles of the airline industry, activation of CRAF, and the impact of changing gauge usage by the CRAF carriers. This project attempts to address the impact these fluctuations have had on CRAF readiness in the period of 1986-2005. To do so, a review of the origins of CRAF as well as its critical role in Department of Defense planning is conducted. Following the review, an analysis of CRAF commitment data provided by AMC A34/B as well as commercial fleet summary data are used to discern trends of both commitment and gauge. The research indicates that economic fluctuations have had limited effect on CRAF commitment levels with regard to single carrier bankruptcy events. However, the extent of the impact is largely dependent on the level of commitment the carrier provides CRAF as well as the abruptness of the event. Additionally, the reduction of gauge in the passenger airline industry will be a cause for concern for defense planners when faced with limited airfield availability. However, cargo aircraft have increased relative gauge size during the period of study.

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## **I. Introduction**

### **Background**

Since its origins in 1952, the Civil Reserve Air Fleet (CRAF) has evolved as an integral part of the United States' military strategy paradigm. Originally conceived as a method to supplement military airlift capability with the movement of reinforcement troops and equipment, CRAF carriers have provided a cost effective alternative to maintaining a fleet of military air lifters capable of meeting contingency planning demands. If an organic capability commensurate with CRAF was to be fielded within the military, the potential cost has been estimated as high as \$50 billion to procure sufficient aircraft and require an annual operating budget of \$1-3 billion (Mach, 2001: 2-3).

However, CRAF has an Achilles heel. The capability of CRAF remains dependent on an industry with the worst profitability record of any major U.S. industry (GAO, 2005: 16). In order to accurately predict the future availability of CRAF, military planners must look to the effects of both previous CRAF activations and financial challenges on both the commercial passenger and cargo airlines as sources of potential CRAF commitment fluctuations. Further, the result of airline attempts to optimize gauge size in response to industry demands must also be considered when attempting to forecast future CRAF capabilities.

## **Problem Statement**

The present state of the airline industry is one of volatility and restructuring. In the years since deregulation, the commercial airline industry has struggled to develop profitable business models capable of surviving economic fluctuations. Despite some isolated successes, the volatility of the airline industry is unsurpassed by any other large U.S. industry in terms of economic fluctuations (GAO, 2005: 16). The impact of this turmoil has been impressive. Since deregulation, 163 airlines have filed for bankruptcy with thirteen of these filings occurring since 2000 (GAO, 2005: 12).

This volatility places military planners in a delicate position. Specifically, a significant portion of military strategic airlift projections is based upon consistent airline participation in the CRAF. The Mobility Readiness Study (MRS-05) published in 2000 relies on 20.5 million ton miles per day (MTM/D) being provided by a fully activated civil reserve fleet (JCS, 200: 4). This effort would constitute approximately 37% of the total estimated airlift requirements by the U.S. military in times of national emergency (Barr, 2004: 7). The need for CRAF is further demonstrated by the fact that even with the full CRAF activation, the airlift shortfall has ranged between 23-31% from the estimated requirements stipulated by MRS-05 (GAO, 2001: 12). In light of these developments, the continued viability of CRAF is a strategic consideration which cannot be overlooked.

## **Research Objectives**

This research project will attempt to identify the impact of both financial and non-financial fluctuations as well as the effect of changes in aircraft size, or gauge, on

historical CRAF capabilities. The ramifications of these effects will also be used to assess the effectiveness of CRAF for future contingency planning. To do so, an analysis of the critical role airlift plays in defense planning as well as present CRAF composition must first be presented as a baseline. Next, utilizing both historical fleet and CRAF commitment data, the author will identify specific CRAF commitment fluctuations resulting from both Defense Department activation and industry financial fluctuations. Further, fleet composition and CRAF capability will be examined with respect to changing gauge utilization.

Once the historical analysis is complete, the potential effects of future CRAF fluctuations will be reviewed in light of present commitment levels. The impact of changes in civilian aircraft gauge will also be examined with respect to potential future contingencies.

It is the hope of the author that this project will provide other researchers with a single source location for the examination of fluctuations induced within CRAF due to both financial and non-financial factors. It will also act as a reference for air mobility professionals to gain a better understanding of the dependence on CRAF by strategic planners and the issues that will face CRAF participants for the near-term future. Finally, this paper will serve as a starting point for future research into the continued reliance of the U.S. Department of Defense on a volatile non-regulated industry.

### **Limitations of Research**

Since the focus of this research project centers upon the fluctuations of CRAF in respect to the program's ability to support the military during major international crises,

only the long range international segment, both passenger and cargo, and the aero-medical segment of CRAF were included in the data. The author recognizes that similar fluctuations occurred in the other CRAF. However, since these segments are not designed to assist the military in international operations, their inclusion was deemed unnecessary.

Additionally, although the topic of incentives is mentioned with respect to CRAF fluctuations, especially following Operation Desert Storm, a detailed explanation of these programs are not included in this project due to the significant number of other research projects already in existence which focus on the effectiveness and necessity of these programs. In order to provide a basic understanding of the incentive process, a summary page of both passenger and cargo Mobility Value Points provided by AMC/A34B are included as appendices. Further, a bibliography of sources which provide excellent analyses of the incentive program is included as an appendix as well.

### **Investigative Questions**

The following investigative questions will be used to address the research objective:

Investigative Question 1: What percentage of CRAF commitment has declared bankruptcy since 2001?

Investigative Question 2: Have fluctuations occurred in CRAF commitment levels when a CRAF participant ceases operation do to financial events such as bankruptcy or consolidation?

Investigative question 3: What fluctuations have occurred to CRAF commitment levels when significant CRAF participants withdraw commitment due to reasons other than financial events?

Investigative Question 4: What effect, if any, has the changing gauge type by U.S. airlines had on CRAF capability?

## **II. The Legacy of Airlift**

### **The Criticality of Strategic Airlift**

The need for a credible and coherent strategic airlift capability has been of paramount importance since the United States' assumption of its role as a superpower following World War II. As noted by Henry "Hap" Arnold in 1945, "we have learned and must not forget that air transport is an essential element of air power, in fact all national power" (Reed, 2002: 24). The premise of strategic airlift as a core enabler of national policy became more apparent following the demise of the Soviet empire and the United States' subsequent drawdown of its overseas military basing requirements. In the decade following the fall of the Berlin Wall in 1989, the United States Army saw its foreign basing presence fall from forty-eight percent of its active force to thirty-two percent (CBO, 1997: 4). This has resulted in a reduction of over 200,000 foreign garrisoned troops during this period. Further, according to President Bush's announcement in August 2004, the number of troops stationed overseas may again be reduced by more than 70,000 in the upcoming decade (Allen and White, 2004: A1).

Despite its withdrawal of forces from overseas bases since the Cold War, the United States military has experienced a historical increase in military operations during the same period. For example, in the first forty years of its existence, the Air Force was involved in ten major overseas contingency deployments. In the decade from 1989-1999, though, the number of deployments rose to eighty (Reed, 2002: 29). This sharp rise in deployments has resulted in a deployment rate of four times greater than the rate of the previous decade (Bolkcom, 2005: 1). This transition from a forward deployed garrison

based military with a static adversary to the present expeditionary concept has enhanced the role strategic airlift capability plays in defense planning (Reed, 2002: 30).

However, the strategic airlift fleet does not presently possess sufficient capability or reliability to fulfill this role. As noted by General Robertson, former Commanding General of United States Transportation Command, “the nation’s number one transportation shortfall is its ailing and numerically inadequate strategic airlift fleet” (Robertson, 2001). This assertion was made in part due to the critical results of multiple capability studies highlighting airlift’s inability to meet strategic planning assumptions. Prior to 2001, U.S. airlift capabilities fell short of the stated Million Ton Mile per day (MTM/D) requirement in eleven of thirteen years (Bolkcom, 2005: 6). Even more alarming was the magnitude of the shortfall. In 2000, the General Accounting Office (GAO) noted the lack of aircraft and insufficient mission capable rates resulted in an airlift shortfall of over twenty-nine percent from planning requirements (GAO, 2000: 9).

Despite this sustained shortfall in airlift, the release of the Mobility Readiness Study 2005 (MRS-05) in 2000 highlighted the increasing criticality the nation’s mobility forces. In this document, the insufficiency of the 49.7 MTM/D airlift capability set forth in the Mobility Requirements Study Bottom-Up Review (MRSBRU) of 1995 was acknowledged. To more realistically predict the requirements of a two Major Theater War (MTW) scenario, MRS-05 provided a range of capability requirements between 51.5 and 67 MTM/D and settled for a minimum moderate risk level of 54.5 MTM/D (JCS, 2000: 4).

Four years after its release, the MRS-05 capability remained elusive to planners. In his address to Congress, General Handy, Commander, U.S. transportation Command,

re-affirmed General Roberston's airlift shortfall statements with an acknowledgement that present airlift capabilities were 9.8 MTM/D short (Handy, 2004). Furthermore, due to the airlift shortfall, General Handy again reiterated the continued inability of current airlift capability to execute the two MTW planning scenario (Barr, 2004: 6).

### **The Airlift Shortfall: The Operation Iraqi Freedom Example**

As a case example of the present state of the airlift fleet, the performance of AMC during Operation Iraqi Freedom (OIF) in the spring of 2003 may be examined. During the initial month of the operation, ninety-one percent of the C-17 fleet and ninety-four percent of the C-5 fleet were committed to the endeavor (Dudney, 2003: 2). This large use of organic forces to ensure adequate capability highlighted a glaring inability to meet additional wartime requirements. In hindsight, the performance of organic airlift during OIF demonstrated a shortfall of 10 MTM/D from current planning documents (Tirpack, 2004: 34). Due to airlift's stress during the conflict, Congress tasked AMC to re-validate the planning assumptions of MRS-05 to better ascertain the actual requirements of combat operations. The results of the "quick look" by AMC resulted in an estimated requirement of 60 MTM/D to support a two MTW strategy further distancing current capability assessments from planning estimates (Tirpack, 2004: 36).

### **Planning Factor Problems in Forecasting Airlift Requirements**

In an effort to predict the requirements for airlift, planners must make estimations on the number and capability of aircraft. Due to the changing nature of warfare, differing contingency requirements, and aircraft evolution, planners are forced to estimate the



usefulness of the airlift fleet. Unfortunately, these estimates rarely serve as accurate predictors of actual capability.

For instance, during Desert Shield/Desert Storm, the C-5 and C-141 daily utilization rates were estimated at 9 and 10 hours respectively. However, post operational analyses revealed actual utilization rates of only 5.5 and 7.1 hours (Brewer, 2004: 49). Further, the planned average C-5 and C-141 payloads during that period were 68.9 and 27.7 tons while the actual results were 62 and 19 tons (Brewer, 2004: 49).

In its 1995 memorandum, the Congressional Budget Office highlighted the problem with defense planning strategy: the planning factors used for mobilized aircraft (both military and civilian) are theoretical and based upon optimized assumptions. However, the actual ability would be far less than the theoretical assumptions used (CBO, 1995: 3).

This overly optimistic prediction of utilization and payload carried into the planning factors used for MRS-05 resulting in MTM/D and Million Passenger Mile per Day (MPM/D) requirements below what would actually be needed in time of mobilization (Graham and others, 2003: 18). As noted in its 1998 Air Mobility Master Plan, AMC uses utilization rates, defined as hours of flight time per day, as a standard measure of capability. For strategic assets, planners estimate a utilization rate of 11.4 hours (surge) and 8.39 hours (sustained) for the C-5B; 15.15 hours (surge), 13.9 hours (sustained) for C-17 aircraft; and 10.0 hours (both surge and sustained) for CRAF aircraft (Department of the Air Force, 1998: 2-28). When compared to historical performance during Desert Storm, the planned utilization of the C-5 seem overly optimistic especially due to the lack of significant reliability modifications for the aircraft since the conflict. In

light of this, the actual capability of the nation's military and civil airlift fleets may significantly fall short of planner expectations.

### **CRAF's Role in Strategic Airlift Planning**

The use of the Civil Reserve Air Fleet in Department of Defense planning formally began with the signing of President Truman's Executive Order in 1952. However, the use of civil aircraft to support military operations began at the origins of aviation itself. Further, the capability of CRAF continues to evolve with ongoing improvement in aircraft technology and changing government requirements.

### **A Brief Background of the Civil Reserve Air Fleet**

The use of civil air fleets for wartime needs has been a reality since the first useful transport aircraft were fielded in large numbers. For the United States, the first large scale use of civilian aircraft occurred during World War II when commercial carriers volunteered aircraft to transport troops and equipment to the European Theater (Teagan, 2002: 6).

Due to the perceived continued reliance on civil airlines for augmenting military airlift capabilities, President Harry Truman in 1947 established a temporary Air Policy Commission, the Findletter Commission, to study the issue. The commission acknowledged the dependency of the military on commercial aircraft in times of mobilization. Further, in response to the ailing financial state of the fledgling airline industry, the commission recommended, "as a potential military auxiliary, the airlines must be kept strong and healthy" (Graham and others, 2003: A-8).

Following the Findletter commission, the military continued to analyze its strategic requirements with regard to mobility. Focusing on airlift, the 1950 Douglass Commission recommended the establishment of a permanent agreement between civil air carriers and the military wherein the airlines would provide modified over-water capable aircraft to the military in times of necessity in exchange for financial assistance (Graham, 2003: A-8). The findings of this commission provided the basis for the establishment of a permanent relationship to organize civil carriers to supplement military airlift in times of military emergencies (Howard, 1996: 2).

Based in part to the findings of the Douglass Commission, President Truman issued Executive Order 10219 in 1951 stating the requirement to:

assemble and analyze data on the requirements of civil air transportation and of the Department of Defense for aircraft of the types used by the civil carriers, and...to formulate such plans and programs, and initiate such actions as may be desirable to meet the requirements for civil air transportation and for the types of aircraft used by civil air carriers, including plans and programs for the transfer or assignment of aircraft from civil air carriers to the Department of Defense, when required to meet the needs of the armed forces as approved by the Director of Defense Mobilization, and...to allocate aircraft of the type used by civil air carriers as required to meet the needs of the armed forces and to maintain essential civil routes and services (Priddy, 1993:15).

In response to the Executive Order, representatives of civil airlines and the Military Air Transport Service (MATs) refined the Douglass Commission report resulting in the March 1952 publication of *The Department of Defense Plan for the Civil Reserve Fleet* (Reese, 2001: 15). This document ended the ad-hoc military-civil airline relationship and replaced it with the first systematic planning strategy for the use of civil airlines to assist the military under predetermined circumstances (Wales, 1998: 14).

In the midst of this period of strategic analysis, another example of the military's reliance on civil airlift capability occurred: the Korean War. Once again, the voluntary use of civil carriers to assist MATS provided the military with an airlift capability unachievable through the use of organic assets. By war's end, civil airlift had transported an impressive sixty-seven percent of all passengers and fifty-six percent of all air cargo (Priddy, 1993: 13).

In the decade following CRAF's establishment, the relationship between the program's civilian participants and the military continued to be subject of much debate. A focal area of these discussions was the relationship the civil airline industry and the military would have during peacetime. Specifically, leaders of the civil airline industry asserted that a large portion of military peacetime airlift needs should be conducted by civil carriers in order to provide a stable industry (Reese, 2001: 16). The military, on the other hand, argued the necessity of peacetime missions to provide training for its own organic forces. What was not debated, however, was the dependency of the military on civil airlift augmentation during times of mobilization (Reese, 2001: 16). To help insure the health of the civil airline industry, Congress in 1958 restricted MATS to carrying cargo unless it was deemed unsuitable for commercial carriers or carried in direct support of tactical operations (Evans 1993: 6). This decision allowed the airlines a guaranteed income by requiring the military to utilize civil carriers for passenger and suitable cargo transport.

Following Congress' approval of the civil air carriers' role in peacetime airlift, President Eisenhower commissioned a panel to further clarify the relationship of the civil industry and the military. The resulting document, *The Role of the Military Air Transport*

*Service in Peace and War*, released in 1960, provided the framework for the nation's airlift policy for the next 27 years (Reese, 2001: 16).

The relationship of civil airlines and the military continued to develop through the 1960's. Although not activated during the Vietnam War, CRAF carriers once again participated on a voluntary basis in the movement of resources. By wars' end, CRAF carriers operating under Department of Defense contracts had transported more than eleven million passengers and 1.3 million tons of equipment (Mach, 2001: 7).

During the latter years of the Cold War, CRAF remained an integral part of the nation's defense strategy, especially during the resurgent focus on military preparedness during the Reagan administration. In 1987, the interdependency of the commercial sector and military strategic airlift requirements was re-emphasized through National Security Decision Directive 280 wherein the President noted that "it is therefore the policy of the United States to recognize the interdependency of the military and civilian airlift capabilities in meeting wartime airlift requirements and to protect those national security interests contained within the commercial air carrier industry" (Reagan, 1987).

For almost forty years, CRAF had existed as an untested concept. On 17 August 1990, however, CRAF Stage I was activated in response to the Iraqi military's invasion of Kuwait. At that time, Stage I was comprised of 18 passenger and 23 cargo aircraft (GAO, 1992: 4). Once activated, CRAF aircraft were used to assist with the movement of personnel and cargo the Persian Gulf region for Operation Desert Shield. In the five months following activation, civil carriers flew 1720 cargo and passenger missions in support of their military commitments (GAO, 1992: 5).

With the onset of hostilities, however, Stage I proved to be insufficient for military demands. Thus, the first activation of CRAF Stage II occurred on 16 January 1991 to assist with the additional requirements of Operation Desert Storm (Department of Defense, 1995: IV-14). The activation of Stage II was accomplished incrementally. At the time of activation, the Department of Defense only called upon the cargo aircraft committed to STAGE II. However, in March of 1991, the passenger portion was also activated to assist with troop re-deployment (GAO, 1992: 5). Upon deactivation of both Stage I and Stage II in May 1991, CRAF carriers had successfully executed more than 2300 passenger and 2800 cargo missions (GAO, 1992: 5).

Although the United States objective of expelling Iraqi forces from Kuwait was achieved during Operations Desert Shield and Desert Storm, the success of CRAF was subject of much analysis following deactivation. However, the benefit of military airlift augmentation provided by the CRAF was undisputable. During the build-up to hostilities, more than a quarter of all air cargo and two thirds of all personnel were transported on the civil fleet (Reingold, 1991: 24). Furthermore, during re-deployment, those numbers rose to eighty-seven percent of the personnel and forty-three percent of the air cargo (Reingold, 1991: 24).

The second period of CRAF activation occurred in 2003 following President George W. Bush's decision to remove the Iraqi government led by Saddam Hussein due to non-compliance of United Nations directives. On February 8, the Pentagon issued a news release outlining the activation of CRAF Stage I to assist the United States Transportation Command (TRANSCOM) in the movement of personnel to the Persian Gulf (DOD, 2003). Instead of activating all 78 participating aircraft in Stage I, however,

General Handy, TRANSCOM Commander, chose to only activate the 47 passenger aircraft included in that stage. The operators of the 31 cargo aircraft, however, were advised that USTRANSCOM reserved the right to call upon them if needed (DOD: 2003). Largely due to volunteerism, the requirement to activate the cargo portion of Stage I was never required (Tirpak, 2003:25). During activation, CRAF passenger aircraft flew 1,625 missions transporting 254,000 troops in support of Operation Iraqi Freedom (Handy, 2004).

### **Present CRAF Structure**

In an attempt to provide the Defense Transportation Network (DTS) with the appropriate level of augmentation, CRAF is divided into three activation levels, Stage I, II, and III (DOD, 1995: IV 9-10). Under present guidance, the President, Secretary of Defense, or the Commander, U.S Transportation Command may activate Stages I and II for any level of emergency; however, Stage I is typically reserved for minor regional crises or expanded peacetime military operations. Stage II is designed to support major regional contingencies or a declared Defense Airlift Emergency (AMC, 2004: 16; Department of the Air Force, 2000: 31). Stage III, according to Joint Publication 04-05, Joint Doctrine for Mobilization Planning, requires the declaration of a state of emergency or national mobilization and may be activated by the same authorities previously mentioned (DOD, 1995: IV 10; Department of the Air Force, 2000: 31).

In addition to flexibility of activation levels, CRAF is further divided by capabilities. These capabilities are termed segments and provide specific airframe types

to the Department of Defense. The following is an excerpt of AMCI 10-402 outlining each segment requirements and capabilities:

**2.33. Criteria.** Aircraft selection criteria for each segment of CRAF are as follows:

2.33.1. International Segment, Long-range Section:

2.33.1.1. Extended Overwater Capability. Long-range aircraft must be equipped and maintained with the navigation, communications, and survival equipment for worldwide extended overwater operations in accordance with FARs.

2.33.1.2. Range. The standard range capability for long-range is 3500NM for both passenger and cargo aircraft. AMC, at its option, may include aircraft with a shorter range capability, when there is a shortfall in long-range capability. However, the minimum acceptable range for this segment/section is the distance from San Francisco to Honolulu (2350NM) with a productive payload.

2.33.2. International Segment, Short-range Section:

2.33.2.1. Cargo. Aircraft must be turbojet or turboprop and capable of transporting a minimum allowable cabin load of 32,000 lbs a distance of 1500NM, departing at sea level in a normal atmosphere. Preferred aircraft should have a door size that will accommodate a standard 463L pallet.

2.33.2.2. Passenger. Aircraft must be turbo-jet or turbo-prop and capable of transporting a minimum of 75 passengers with a corresponding minimum ACL of 30,000 lbs a distance of 1500NM departing at sea level in a normal atmosphere.

2.33.3. AE Segment. The aeromedical capability of AMC includes the B-767 aircraft modified with AESS. (Other aircraft may, in the future, be added to this segment.) When needed, these aircraft will be fitted with AESS, the equipment specifically designed to convert B-767s for the AE mission. These aircraft must be capable of flying a distance of 3500NM with a full payload and also be equipped and

maintained with navigation, communication, and survival equipment for worldwide extended overwater operations.

2.33.4. Domestic. The CRAF Domestic Services Section support wartime CONUS passenger and cargo airlift requirements.

2.33.4.1. Passenger. Aircraft must be turbo-jet or turbo-prop and capable of transporting a minimum of 75 passengers with a corresponding minimum ACL of 30,000 lbs a distance of 1500NM departing at sea level in a normal atmosphere.

2.33.4.2. Aircraft must be turbo-jet or turbo-prop and capable of transporting a minimum Allowable Cabin Load (ACL) of 32,000 lbs a distance of 1500 nautical miles, departing at sea level in a normal atmosphere. Aircraft must have a door size that will accommodate a standard 463L pallet measuring 88 x 108 inches.

2.33.5. Alaskan. The CRAF Alaskan Section supports intra-Alaska operations. Aircraft selected for allocation must be located and available in Alaska. These aircraft are allocated to 11 AF and Alaskan NORAD region wartime airlift requirements in Alaska, northern Canada, and the northern Pacific.

(AMC, 2004: 18-19)

To provide a more robust ability to match CRAF stage and segment capability with the needs of a particular contingency, AMCI 10-402, *Civil Reserve Air Fleet* (CRAF), allows for further specificity of activation. Namely, CRAF may be “activated/deactivated incrementally or in total, by stage segment, section and elements. The government retains the option of activating any portion of each stage or segment as required” (AMC, 2004: 11). As noted earlier, both historical periods of activation utilized this option. Once activated, CRAF carriers are required to supply both aircraft



and crew compliments (four crews per committed aircraft) within 24 hours for Stage I & II and 48 hours for Stage III (AMC, 2004: 15).

In order to qualify for CRAF participation, carriers must meet certain criteria to aircraft capability. Specifically, carriers must be a certified Federal Aviation Administration Part 121 carrier, listed as a DOD approved carrier, and have at least one-year prior uninterrupted service (AMC, 2004: 17). Further, to be included in the long range international segment, U.S. flagged passenger carriers must commit thirty percent (15% for cargo carriers) of their fleet to CRAF as well as be capable of providing 10 hours per day of utilization (Air Mobility Command Public Affairs Office, 2005; AMC, 2004: 17). Additionally, the Department of Defense outlines the qualifications of the carriers' crewmembers. Specifically, all flight deck crewmembers must be U.S. citizens capable of obtaining a SECRET clearance and, in order to avoid inadvertent loss of CRAF capability due to military operations, CRAF aircrews cannot be members of the military Reserve or National Guard (AMC, 2004: 11).

### **CRAF Capabilities**

With the capability of the organic fleet largely static due to long lead times for new aircraft production and limited aircrews to fly these aircraft, the only flexible portion of the strategic airlift system is the CRAF. CRAF provides planners the opportunity to augment the organic military fleet with a graduated level of participation based on the Stage activation process, as mentioned previously. In order to provide a common unit of measure between varying aircraft types, AMC A34/B incorporates a conversion factor to obtain Wide Body Equivalents (WBE) for each civilian aircraft committed. Presently,

CRAF participation as a result of Stage III activation is forecast to provide AMC with 93% of its international passenger capacity, 98% of aero-medical airlift capacity, and 41% of international air cargo capacity (Handy, 2004). In terms of WBE, this equates to 120 long-range cargo WBE and 136 long-range passenger WBE. No specific WBE is stipulated for AE, a commitment of 44 compatible B-767 aircraft is required by DOD planners (GAO, 1996: 3).

From a positive perspective, the history of CRAF's ability to meet the needs of mobility planners has a more successful record than that of the organic fleet. Since the MRSBRU of 1995, CRAF has consistently provided the 120 WBE cargo capability as well as the 136 WBE capability for passenger transport (GAO, 2001: 12). However, planners have been reluctant to extend the CRAF cargo commitment beyond 20.5 MTM/D due to the burden Stage III activation could pose on commercial aviation (Coffey, 1996: 3-18). A further analysis of this dilemma will be presented later in this project.

Despite the success of CRAF in providing adequate planning capability, the aggregate strategic airlift fleet remains inadequate. According to the Mobility Requirements Study conducted in 2001, organic airlift was capable of providing 23.9 MTM/D. When the full CRAF panning commitment of 20.5 MTM/D is incorporated, a combined total of 44.4 MTM/D is achieved (Reed, 2002: 30). This theoretical capability remains well short of the 54.5 MTM/D stipulated in MRS-05 and even less impressive when compared to the 60 MTM/D recommended by the "quick look" review of 2004.

### **III. Methodology**

To best examine the fluctuation of CRAF commitment levels incurred by both financial and non-financial factors, a systematic review of historical data sources was necessary. Specifically, the HQ AMC Form 312 (and previous versions) was used to provide specific data on CRAF commitment levels and composition during the period of interest. To gain a better perspective of the industry at large, fleet summary data was compiled to provide a comprehensive view of airline fleet composition. This allowed for an analysis of industry trends in terms of fleet composition and insight into the inter-relationship of the airline industry and CRAF.

#### **CRAF Commitment Review**

As a tool for planners, AMC/A34B publishes a HQ AMC Form 312, CRAF Capabilities Summary, on a periodic basis and updates this summary whenever CRAF commitments change. By analyzing this data, trends concerning overall CRAF capability and individual carrier commitment levels can be directly evaluated. Indirectly, the effects of incentives, and economic effects on CRAF can be derived as well. For this research project, annual Form 312's published in January of each year were collected from 1986 to the present. Although additional form 312's may have been published at different intervals to highlight changes beyond the normal annual commitment, these additional forms were not included in the graphical trend data since a consistent review period was

desired. However, the most current HQ AMC Form 312, dated October 2005, was used to help identify current trends in the discussion section.

### **Aircraft Fleet Summary Review**

As part of the services offered to its readers, Air Transport World publishes an annual summary of world aircraft fleets. This summary, when tabulated over a multi-year period, provides insightful data on the trends of airline fleet decisions with regard to business models and economics. However, Air Transport World data is unavailable prior to 1993. In order to develop trend information prior to this time, the use of Airline Transport Association (ATA) data was collected. Unfortunately, the information provided by ATA is not as exhaustive in nature since only ATA members are documented. As a result, the correlation between these two data sources must be considered. It is worthy of note, however, that the members of the Air Transport Association comprise in totality all U.S. flagged large aircraft operators with international capability. Since this project specifically targets the long range international (both cargo and passenger) as well as the aero-medical segment, the data provided by the ATA database can be viewed as sufficient for comparison.

## IV. Analysis

### Major Bankruptcies of the 1990's

Following the tumultuous wave of new entrants and consolidations following deregulation, the airline industry experienced its first significant economic challenge in the early 1990's. Not only did the economy enter into recession, but the onset of hostilities with Iraq further exacerbated the reduction of commercial traffic. As a result, several airlines with weakened financial structures were forced to enter bankruptcy.

#### *Pan American.*

Perhaps the most recognized U.S. flag carrier prior to deregulation, the failure of Pan Am is of specific interest in determining the effects of airline failures with regard to CRAF capabilities. Immediately upon the signing of the Airline Deregulation Act in October 1978, Pan Am realized the imperative need to develop a domestic feed capability to sustain its established international operation in the new competitive environment. Five days after the legislation was signed, Pan Am announced the discontinuation of service to several European destinations and its intent to develop a domestic capability (Siddiqi, 2000). Pan Am acquired National Airlines in 1980 for this purpose, but the merger did not provide Pan Am with the coherent and efficient route structure it desired. As a result, the company's financial position began to erode. In an effort to improve its cash position, Pan Am sold its Pacific routes and aircraft to United Airlines in 1985. Five years later, still experiencing financial troubles, Pan Am sold its New York-London route to United. Without a coherent domestic structure and following the sale of its most lucrative international operations, Pan Am filed bankruptcy in 1991 and ceased its CRAF participation soon thereafter (Siddiqi, 2000).

According to AMC Form 312 data, during the period of 1986 until Pan Am's withdrawal from CRAF in 1992, the airline committed an average 35 aircraft to the long-range passenger fleet. This constituted approximately 14% of total annual CRAF capability for that segment.

The demise of Pan Am occurred at a particularly interesting period. Following Operation Desert Storm, CRAF's first activation, CRAF participants were forced to contend with both an economic downturn as well as the realization that CRAF could be activated. As a result, during the period of 1991-1993, passenger capacity fell from 223 WBE to 208 WBE (see Figure 1). This trend of decreasing capability continued until the fleet reached a capability low point of 81.1 MPM/D (110.1 WBE) in 1994. The withdrawal of Pan Am exacerbated the capacity reduction and can, therefore, be considered a contributing factor to the decline of passenger capability following the conclusion of Desert Storm. It was not until the implementation of incentives and the reduction in planning requirements by the government that capability rose above minimum requirements in 1995.

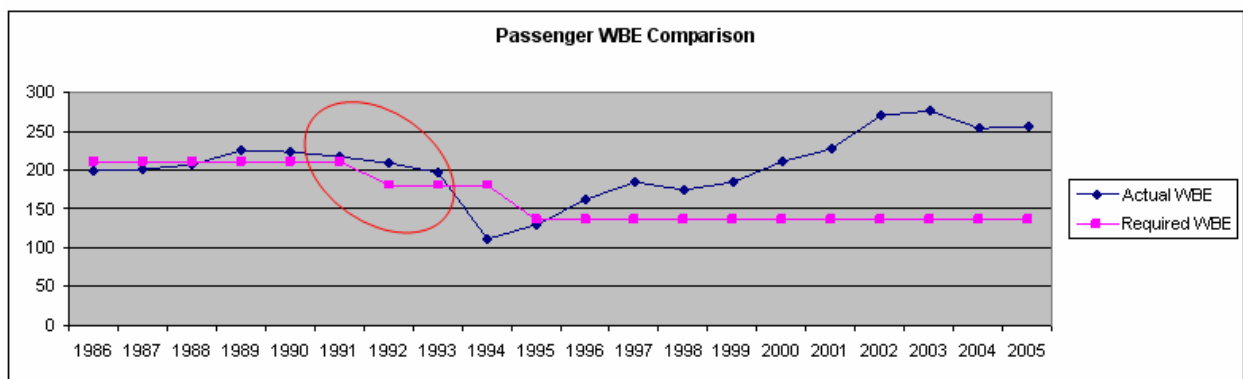


Figure 1. Passenger WBE Trends 1986-2005 (HQ AMC Form 312 data)

With regard to CRAF's long-range international cargo segment, the loss of Pan Am's 18 B-747 freighter and combi (part passenger/part cargo) aircraft was even more significant. In 1992, CRAF experienced a drop in MTM/D of over 14% due to the loss of Pan Am's freighters as well as a commitment reduction by FedEx (see Figure 2). The loss of Pan Am's freighters was not only a MTM/D setback. Pan Am was the largest operator of CRAF Enhancement Program aircraft, possessing 15 aircraft modified with re-enforced floors to accommodate heavy military loads. As a result of Pan Am's cessation of operations, the DOD lost access to most of the modified aircraft due to their sales to non-CRAF carriers, including foreign buyers (Lewis, 1998: 35). It took several years before the majority of these aircraft were acquired by other CRAF carriers and re-introduced to CRAF (Tirpak, 1996: 30).

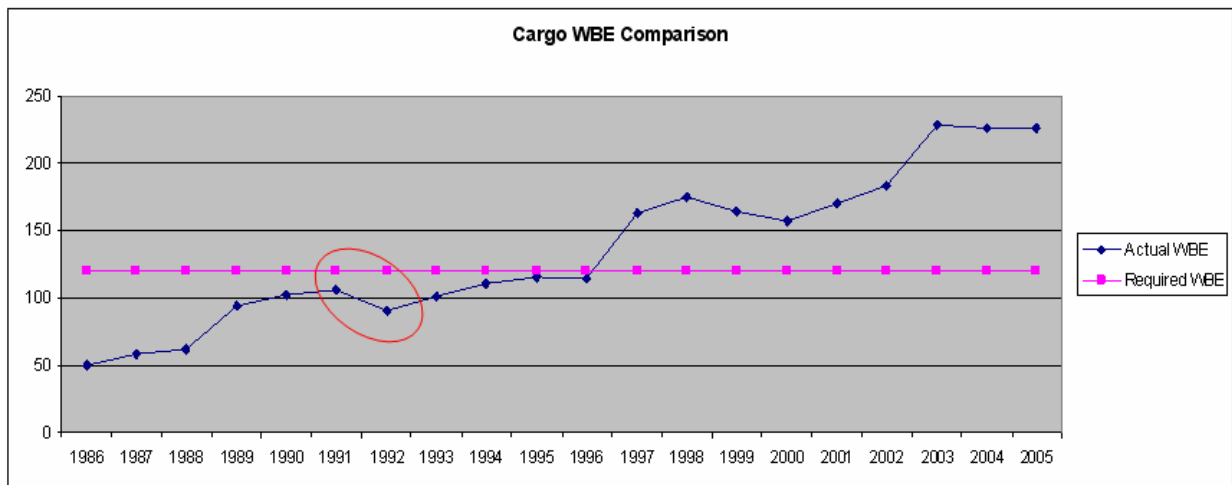


Figure 2. Cargo WBE Trends 1986-2005 (HQ AMC Form 312 data)

### ***Trans World Airlines.***

Another airline with historical roots dating to the origin of American civil aviation, Trans World Airlines (TWA) provided a steady commitment of 18% of CRAF

long-range passenger capability from 1986 to 1990. Additionally, in 1991, the airline committed eleven B-767 aircraft to the CRAF program as an initial contributor to the newly formed Aero-Medical (AE) aircraft segment. These aircraft comprised 33% of the initial civilian AE capability. However, following the company's 1992 bankruptcy filing, TWA atrophied throughout the 1990's (AMR Corp, 2001: B11). The carrier remained an active participant in both the passenger and AE CRAF, but its aircraft commitment rates fluctuated with the financial turmoil occurring in the company. Finally, in 2001, TWA again declared bankruptcy and was acquired by American Airlines (Johnson and Kahn, 2001).

Although TWA was a major contributor to CRAF in the 1980's and early 1990's, the demise of TWA had little effect on CRAF long-range passenger capability. During its decade of financial troubles, TWA had decreased in significance from eighteen percent of CRAF capability to merely five percent at the time of its acquisition by American Airlines. Furthermore, the waning years of TWA's existence coincided with a marked increase in CRAF participation largely due to the effectiveness of the incentive program implemented in 1995. Thus, the airline's withdrawal was insignificant despite its long legacy.

From an AE perspective, the removal of TWA's B-767 aircraft along with a coincident reduction of 22 aircraft by Delta resulted in a loss of forty-seven percent of the AE MPM/D capability in 2001 (see Figure 3). In terms of impact, though, the removal of TWA's three remaining committed aircraft was far less significant than Delta's fluctuation. The following year, Delta returned 15 of its aircraft to CRAF essentially



virtually eclipsing any capability losses. As in the passenger segment, TWA's withdrawal went largely unnoticed in terms of capability.

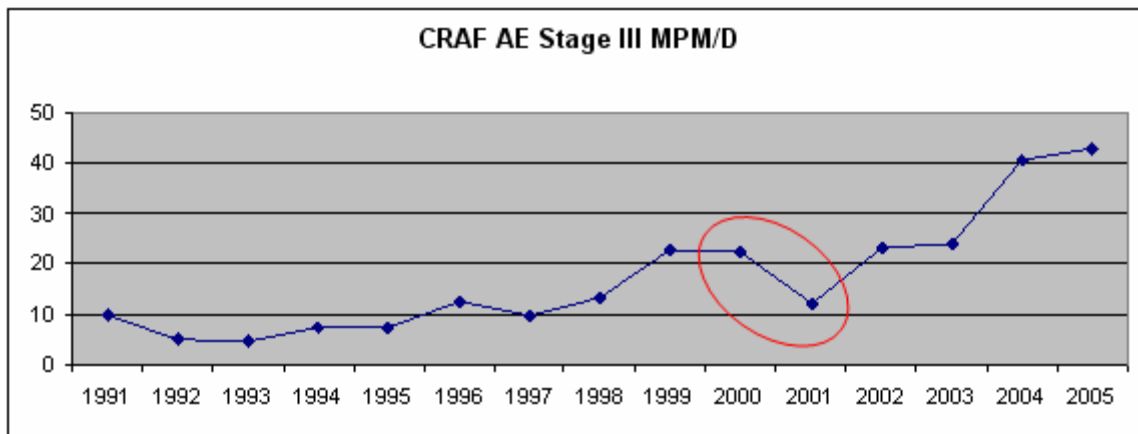


Figure 3. CRAF Aero-Medical MPM/D Trends 1991-2005 (HQ AMC Form 312 data)

### *Emery.*

The demise of Emery Air Freight as a CRAF carrier came as result of an FAA directive to suspend the carrier's operations following two closely-timed aircraft accidents. In the months following its August 2001 accident, Emery Air Freight was shut down by its ailing parent company, CNF, and its assets were sold (Webber, 2002: 22). CNF filed bankruptcy several months later.

According to HQ AMC Form 312 data, Emery began its CRAF participation in 1989 as part of a teaming agreement with other cargo carriers and was a consistent CRAF participant until the carrier ceased operations. In the year prior to its withdrawal from the program, Emery offered 24 DC-8 aircraft and 7 DC-10 aircraft providing approximately 14.4 WBE. These aircraft accounted for approximately eight percent of the long-range cargo WBE capability dedicated to CRAF Stage III in 2000. Despite this significant contribution, the abrupt loss of Emery's commitment in 2002 did not have a negative

effect on CRAF capability. Instead, Emery's withdrawal was eclipsed by FedEx's increased commitment of 12 aircraft for that year as well as the increased participation of Atlas Air, whose additional pledge of 16 B-747 freighter aircraft contributed to an overall rise in commitment to 200% of CRAF requirements.

### **Major Bankruptcies Following September 11, 2001**

The events of September 11, 2001 caused unprecedented chaos to the nation's economy and, more specifically, the airline industry. Following the attack, all non-military air traffic was grounded resulting in an immediate financial loss of \$1.36 billion in the passenger airline industry (Teagan, 2002: 32). However, even more massive losses were incurred by all segments of the commercial aviation industry in the months that followed. Initial estimates of industry losses following September 11, 2001 ran as high as \$24 billion (Mullin, 2001). According to the Air Transport Association, this shock to the industry has resulted in 19 bankruptcies to date with seven carriers no longer in service (ATA, 2005).

Surprisingly, however, the effect of September 11 and the financial fluctuations it caused did not significantly affect CRAF capability. In fact, participation has risen since the event. Although 10 of the 19 carriers that filed for bankruptcy were CRAF participants, only one of those carriers file Chapter 7 bankruptcy. Further, several of the largest CRAF passenger participants have significantly increased their commitments in spite of their bankruptcy filings. The following paragraphs provide an analysis of each bankrupt carrier's participation during this period.

The only long-range international CRAF carrier to cease operations following September 11, 2001 was Sun Country Airlines. Largely a charter operation with some limited scheduled service from Minneapolis-St. Paul, the carrier filed Chapter 7 in January 2002 resulting in the immediate cessation of operations (Tellijohn, 2002). However, Sun Country was a minor CRAF participant and only provided three aircraft to the program in the year prior to bankruptcy. In the year following its Chapter 7 bankruptcy, Sun Country resumed operations, but no longer participated in the CRAF program,

A more significant CRAF participant, American Trans Air (ATA), filed for Chapter 11 bankruptcy protection in October 2004 (Skertic, 2004: B1). Originally a charter carrier, ATA had evolved into a major airline (\$1 billion in revenues) during the 1990's with a network of scheduled service added to its charter operations. Since its certification as a common carrier in 1982, ATA has been a consistent CRAF participant. In the year prior to bankruptcy, ATA committed 33 B-757 and L-1011 aircraft. In the year following its filing, however, ATA offered only 18 aircraft for CRAF service.

Yet another long-range international CRAF carrier which filed Chapter 11 following the events of September 11<sup>th</sup> was Hawaiian Airlines (Segal and Lynch, 2003: A1). Despite its reorganization filing in March, 2003, Hawaiian Airlines' CRAF commitment has remained unchanged. The carrier pledges four Boeing 767 to CRAF Stage III passenger operations.

The only dedicated cargo carrier to file bankruptcy since September 11 is the combined holding company that oversees the operations of both Atlas and Polar Air Cargo. Following Polar's financial difficulties in the late 1990's, Atlas acquired Polar

Air Cargo in early 2002. However, the merger of the two B-747 freighter carriers did not result in the avoidance of bankruptcy. In January 2004, Atlas Air Worldwide Holdings filed for bankruptcy. Prior to filing, both carriers were significant contributors to the CRAF fleet dedicating a combined 48 B-747 aircraft. At the end of 2005, the carriers had reduced the number of committed aircraft to 34.

Of particular interest with respect to CRAF and bankruptcy filings are the commitment trends of three of the largest CRAF passenger participants: United, Delta, and Northwest. Unlike the other participants operating in bankruptcy who either reduced commitments or remained constant, these three carriers have significantly increased their CRAF commitments.

Operating under Chapter 11 protection for the longest period in aviation history, United Airlines filed for bankruptcy in 2002 following the company's unsuccessful attempts to obtain loan guarantees from the Airline Transport Stabilization Board (Adams, 2006: B1). Since its entry into Chapter 11, United's commitment to CRAF has risen from 82 long-range aircraft in 2002 to an October 2005 commitment of 114 aircraft. During this period, United's passenger commitment has remained steady. However, the marked rise in commitment can be attributed to the carrier's increased pledge of 31 B-767 aircraft to CRAF's AE segment.

Similar to United, both Northwest and Delta Airlines have also increased their CRAF commitments after filing bankruptcy. Prior to filing, Delta had committed 57 aircraft to the passenger and AE CRAF segments while Northwest provided 54 to the passenger segment and 12 B-747F to the cargo segment. Following their simultaneous

bankruptcy filings on September 14, 2005, Delta's long-range commitment rose to 79 aircraft and Northwest increased its input to 89.

### **Non-Bankruptcy Related Fluctuations**

Although financial stress has proven to be a prime culprit for the fluctuation of the airline industry and, subsequently CRAF, other significant events have occurred during the period of study which resulted in CRAF commitment fluctuations. Most notably, the historic first activation of CRAF during Desert Shield/Desert Storm caused both the military and the civilian carriers to re-evaluate the execution of the program. Later in the decade, CRAF again experience a capability fluctuation, this time unrelated to either financial considerations or activation. In this instance, the combined effects of several smaller carriers entering and exiting the program resulted in a discernable effect on CRAF capability.

#### ***Desert Shield/Desert Storm.***

As mentioned previously, CRAF has only been activated on two occasions, both in response to hostilities in Iraq. As a result, the opportunity to assess the impact of CRAF activation on the civil airline industry has been limited. That being said, the first activation of CRAF for Operations Desert Shield and Storm resulted in significant stress to both passenger and cargo carriers which subsequently caused commitment fluctuations.

The use of civil passenger carriers during Operation Desert Shield and Storm was critical to the success of military operations. However, activation was not without burden to the carriers. During post-activation analysis by the General Accounting Office, U.S.

passenger carriers noted that the initial activation occurred during the lucrative holiday travel season. As a result, CRAF passenger airlift participants were forced to concede business to non-CRAF carriers (GAO, 1992: 8, CBO, 1997: 16).

Common to both passenger and cargo operators was the issue of aircraft utilization. Following activation, carriers complained of the under-utilization of committed aircraft (GAO, 1992: 9). According to DOD policy, during CRAF activation, carriers are compensated based upon the number of hours each aircraft is utilized with flight time used as the unit of measure (AMC, 2004: 28). Since flight hours was the compensatory measurement, air carriers complained of excessive ground times at both loading and unloading locations resulting in reduced revenue (GAO, 1992: 9). Additionally, the air carriers were forced to contend with possible gaps in insurance coverage while fulfilling their CRAF requirements (GAO, 1992: 9).

Following Desert Shield and Desert Storm, the issues associated with activation as well as the lack of adequate incentives for participation in the CRAF program began to be reflected in commitment levels. From 1990 to 1993, CRAF passenger capabilities fell from 158 to 139 MPM/D. However, the most significant drop in CRAF capability occurred in 1994. That year, both American Airlines and United Airlines withdrew entirely from the program and both Continental and Northwest reduced their CRAF participation. This resulted in the loss of 105 aircraft thereby reducing the MPM/D from 139.5 to 81.1 (see Figure 4). In terms of WBE, 1994 CRAF Stage III could only guarantee 110.5 WBE while the goal remained 136 (Department of the Air Force, 1998: 2-31). This prompted Air Mobility Command to implement the Government City Pairs program and institute Mobility Value Points for CRAF participation (Lewis, 1998:36).

The following year, CRAF Stage III returned to 129 WBE. In 1996, commitments again jumped to 161 WBE, a level well in excess of the 1995 MRSBRU.

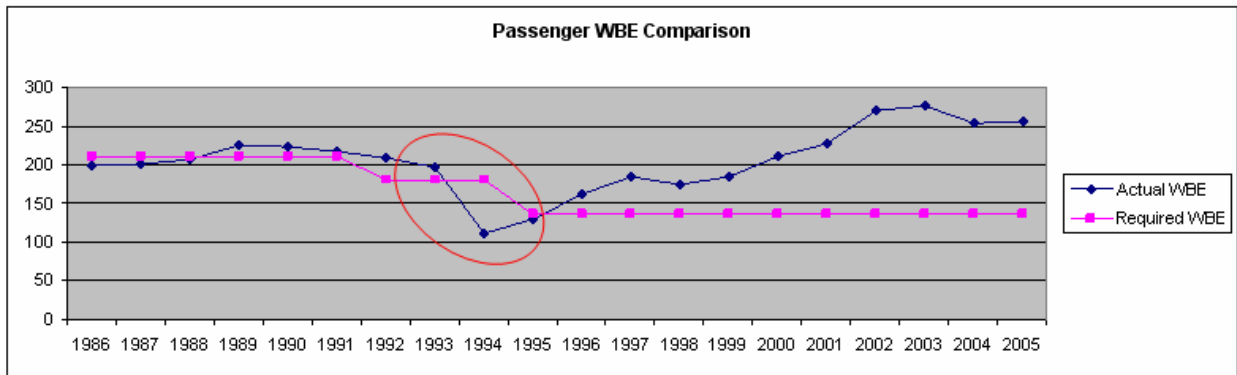


Figure 4. Passenger WBE Trends 1986-2005 (HQ AMC Form 312 data)

Like their passenger counterparts, CRAF long-range cargo participants also faced challenges both during and after Desert Shield/Storm. During the activation period, some foreign customers signed long-term contracts with foreign cargo carriers in an effort to ensure uninterrupted service. Once the activation ended, these contracts prohibited the U.S. carriers from resuming service (GAO, 1992: 8). United Parcel Service (UPS) was a CRAF participant that asserted this claim.

Further, prior to activation, UPS had committed four aircraft to Stage II, including three B-747-100 freighters. In the months during activation, UPS was forced to lease aircraft to maintain their commercial business while accommodating the activation of CRAF aircraft (Coffey, 1996: 2-4). In response to its negative experience with CRAF, the cargo company reduced its CRAF commitment to the minimum 15% (Donovan, 1996: 26). This minimum commitment by UPS has remained through latest CRAF data collected in October 2005 despite the carrier's significant international fleet growth.

In addition to UPS's negative CRAF experience, FedEx also reduced participation in the year following Desert Storm. The cargo carrier had committed 42 aircraft at the beginning of 1991. However, FedEx reduced its 1992 commitment to 31 aircraft. The reduction of FedEx and UPS, as well as the bankruptcy effect of Pan Am, caused the number of Wide Body Equivalents to fall from 106 to 91 (see Figure 5). However, the long-range cargo segment was much quicker to re-establish commitment than the passenger carriers. By 1994, CRAF cargo participation exceeded pre-Desert Storm levels.

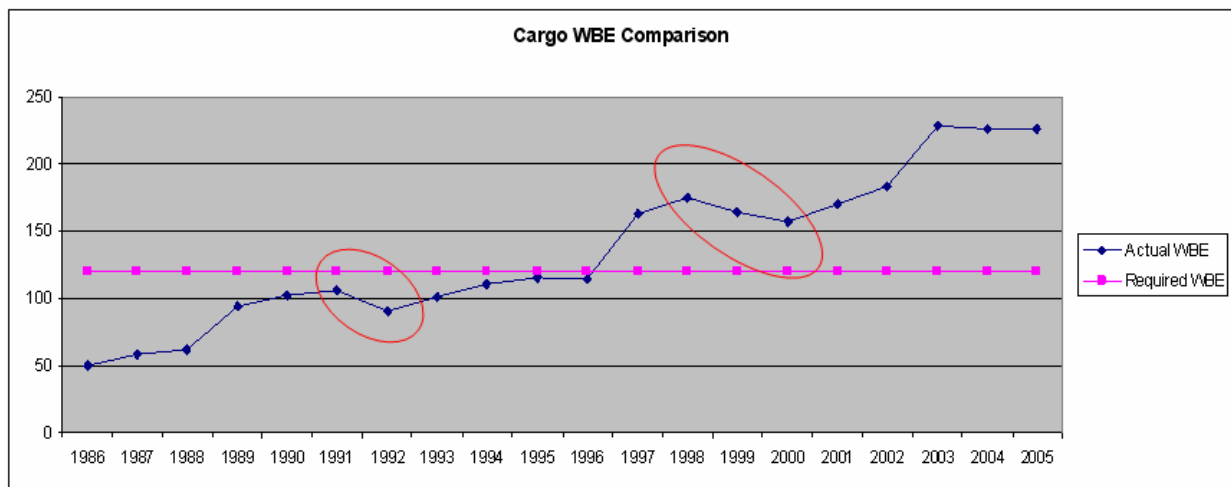


Figure 5. Cargo WBE Trends 1986-2005 (HQ AMC Form 312 data)

However, possibly the most significant event of the conflict with regard to CRAF occurred in the early months of 1991. Despite the activation of Stage II and the full utilization of active and reserve military airlift assets, the requirements for cargo airlift exceeded available capacity. The result was a growing backlog of bulk cargo at the main debarkation point of Dover AFB, DE. In response, airlift planners considered requesting for activation of Stage III. However, major airline carriers strenuously resisted this



consideration due to the impact such activation would have on their fleets (Brewer, 2004: 55). In an effort to avoid Stage III, civil cargo airlines increased their level of volunteer aircraft.

The use of volunteer aircraft during times of airlift shortfall can be viewed as both a benefit and a hindrance. Airlines may volunteer aircraft for a number of reasons. For example, the use of volunteer aircraft may provide sufficient airlift to avoid further activation such as the case of Desert Storm, or activation altogether, such as the use of volunteer cargo aircraft during Operation Iraqi Freedom. Volunteering aircraft may also be a productive way to use underutilized aircraft during an economic downturn as seen following September 11, 2001 (Maynard, 2003: B1). Further, smaller non-scheduled operators may benefit from the increased need for volunteer aircraft due to more predictable utilization rates.

Volunteerism can also provide a planning dilemma. In the case of Desert Shield/Desert Storm, the activation of Stage I in August 1990 called for the commitment of 38 aircraft. However, 28 of those aircraft were already participating in the build-up as volunteers (Fricano, 1996: 37). The same predicament occurred during the activation of Stage II in January 1991. At that time, of the 76 aircraft activated, only 10 were not already involved with the war effort (Fricano, 1996: 37). This problem of “double counting” adds another dilemma to airlift planners.

#### ***Non-Activation Fluctuations.***

In the latter half of the 1990's, a CRAF cargo capability reduction occurred not related to activation. In 1998, CRAF cargo capability stood at 174 WBE. Two years later, CRAF commitments had fallen to 157 WBE. This degradation in commitment can

be attributed to fluctuations in the commitment levels of several smaller cargo operators. First, Air Transport International, a small charter carrier, reversed its gradual participation increase by removing 10 aircraft from the CRAF fleet between 1998 and 2000. Next, American International/Kalitta (CKS) abruptly withdrew from the program in 2000. CKS had consistently committed approximately 30 aircraft to Stage III for the five years preceding this event. The effect of these events resulted in the loss of approximately 17 WBE (see Figure 5). Despite this, the year 2000 commitment level of 157.71 WBE well exceeded the CRAF requirement of 120 WBE.

### **Gauge Analysis**

In an effort to adapt to industry volatility, air carriers must determine an appropriate business model in which to operate. The most prevalent business model, the hub and spoke system, is used by all carriers that conduct long-range international operations. These carriers, termed legacy carriers due to their origins early in the evolution of the commercial airline industry, rely on the hub and spoke model to provide sufficient density to economically sustain both domestic and international operations (Carey and McCartney, 2004: A1). In order to optimize this model, legacy carriers field a variety of different sized aircraft, or gauge, to fit the capacity and subsequent operating costs to density.

The decision of aircraft gauge represents a significant strategic decision for air carriers. Due to the required lead-time, financial outlay, and lifecycle expectation of new aircraft, air carrier management must attempt to determine the revenue trends of the airline industry as far in advance as possible. In simple terms, large expensive aircraft

are capable of servicing more passengers per gallon of fuel, termed revenue per available seat mile (RASM), as well as providing other efficiencies, such as scheduling, crew manning, and lower airport arrival/departure requirements, or slot times. Smaller, less expensive aircraft provide the advantage of increased frequency and more destination opportunities at the expense of higher cost per available seat mile (CASM). Airlines must weigh the comparative advantages of each type of aircraft when making fleet decisions.

***Passenger Fleet Gauge Trends Following Deregulation.***

Prior to deregulation in 1978, governmental oversight via the Civil Aeronautics Board (CAB) established the level of competition, frequency, and fares U.S. air carriers could charge. (Levine, 2003: 41). This limitation on competition and fare structures resulted in an industry dominated by large carriers with entrenched route structures (Levine, 2003: 41). As a result of growing interest in airline passenger travel, airlines faced the dilemma of insufficient capacity on their most popular routes. Airline managers attempted to remedy this problem through the acquisition of large capacity aircraft capable servicing the airline's most lucrative routes (Wells and Wensveen, 2004: 55). The newly introduced Boeing 747 as well as the McDonnell Douglas DC-10 and Lockheed L-1011 became popular choices for U.S. commercial airlines during this period. However, the energy crisis of the mid-1970's resulted in significant challenges for the CAB. Due to government regulatory oversight, airline operators were guaranteed to incur a profit. In order to sustain unprecedented rises in industry costs due to increased overhead and fuel, ticket price increases were seen as the only alternative. Instead, the federal government chose to allow market forces to provide economic relief. The Airline

Deregulation Act of 1978 stipulated the requirement to fully deregulate the passenger airline industry by 1981 (Levine, 2003: 41).

The rapid expansion of the passenger carrier industry in the decade following deregulation resulted in the overall fleet growth of both wide body and narrow body jet aircraft. During this period, the total number of passenger jet aircraft increased 77% from approximately 1,950 aircraft in 1978 to approximately 3,500 aircraft in 1988 (ATA, 1979: 17; ATA 1989: 9). This growth began slowing the following year largely due to the onset of an economic recession and the Persian Gulf War (GAO, 2005: 29). However, U.S. passenger airlines continued to expand their fleets throughout the 1990s. It was not until the next economic downturn and the attack on September 11, 2001 that passenger airline fleet expansion halted (GAO, 2005: 29). Since that time, passenger fleets have remained largely static (see Figure 6).

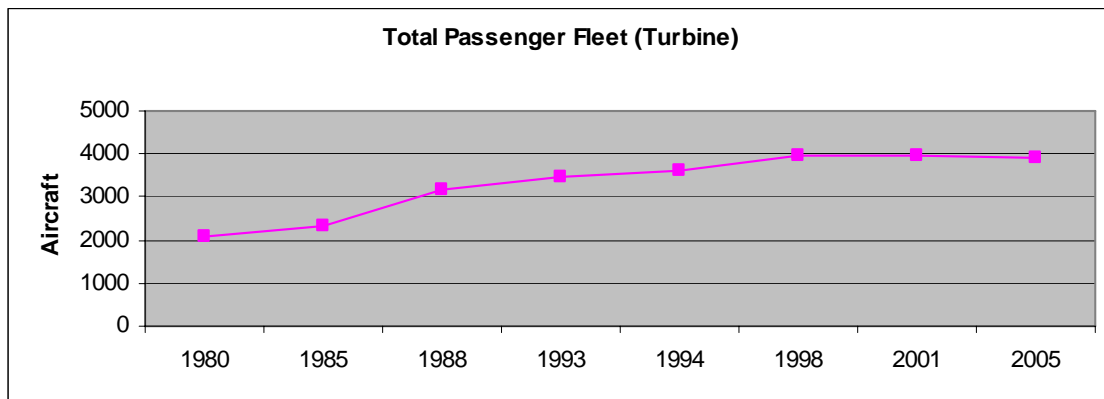


Figure 6. Civil Passenger Fleet Growth 1980-2005 (ATA & ATW data)

In terms of fleet composition, deregulation of the passenger airline industry resulted in significant changes for U.S. carriers. In the years immediately following deregulation, legacy air carriers were forced to contend with the effects of a recession,

avoid over-expansion, endure high fuel costs, and survive a surge of start-up carriers. The legacy carriers did so largely through the evolution of hub operations (Levine, 2003: 41). Simply, hub operations allow network carriers to funnel large numbers of passengers through major airports in order to facilitate connections to virtually any location serviced by the carrier. In order to maximize the number of travelers in the hub system, smaller gauge aircraft are used to service less dense routes. These passengers are then moved on larger gauge aircraft between major hubs and international destinations (Daly, 1997: 23).

Due to the rapid initial growth of the industry and the lack of viable regional jets, however, the trend of smaller gauge aircraft does not begin to be detected in airline fleet statistics until a decade after deregulation legislation was enacted. Beginning in 1988, however, the initial downward fleet trend of the largest passenger aircraft, the B-747, by passenger carriers becomes evident (see Figure 7). This reduction continues throughout the most recent data procured in 2005. At its highest point, 135 B-747 aircraft were operated by CRAF passenger segment participants in 1988. In 2005, that number had been reduced to 73. In terms of new aircraft orders, the Boeing Company's ordering statistics reveal 72 B-747 aircraft orders since 2002. None of these orders, however, have been placed by US passenger carriers (Boeing, 2006).

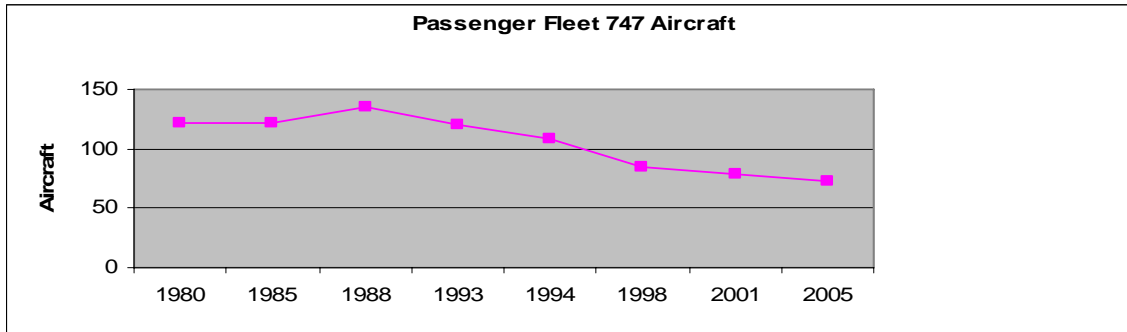


Figure 7. Boeing 747 Passenger Fleet Usage 1980-2005 (ATW/ATA data)

In stead of investing in large wide body aircraft, the majority of aircraft acquisitions by passenger carriers have been in the narrow body (single aisle) category since deregulation (see Figure 8). Participants in the Long Range International Section of CRAF have expanded their fleets by 2,750 aircraft since 1980. Only approximately 250 of these aircraft are classified as wide body. Further, since 1993, the wide body fleet growth of CRAF passenger airline fleets have virtually ceased (see Figure 9).

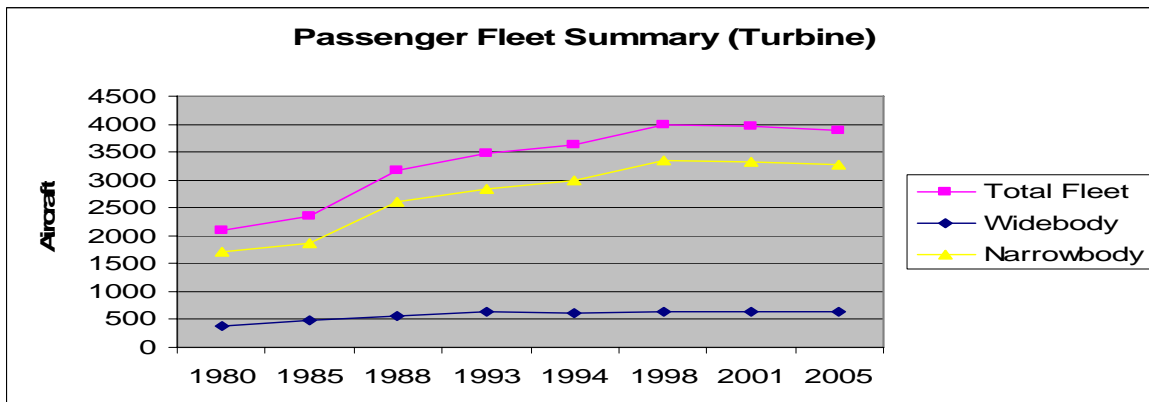


Figure 8. Passenger Fleet Turbine Aircraft Type Summary 1980-2005 (ATA & ATW data)

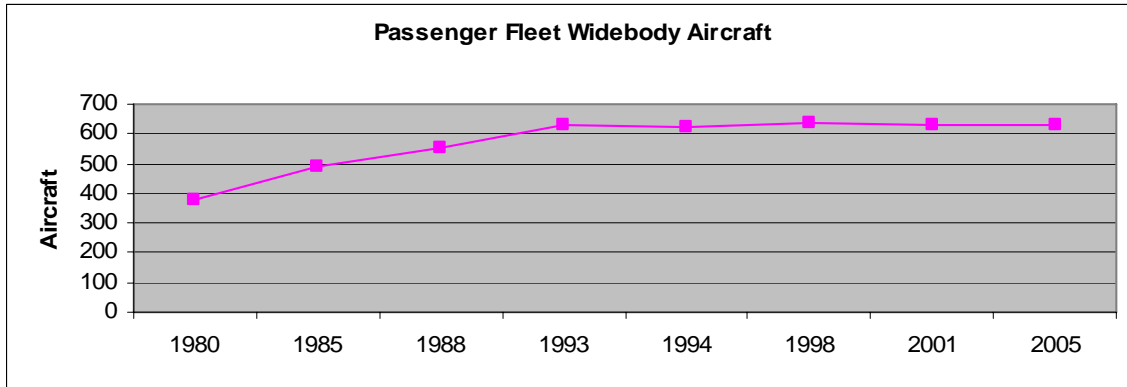


Figure 9. Wide-Body Aircraft Passenger Fleet Data 1980-2005 (ATA & ATW data)

When International Long Range Passenger Segment aircraft trends are examined via CRAF data, the results of narrow body procurement become evident. Using million passenger miles as a unit of measure, Figure 10 demonstrates the gradual increase of required aircraft to provide the same unit measure of airlift capability. The ramifications of this trend will be discussed in a later section.

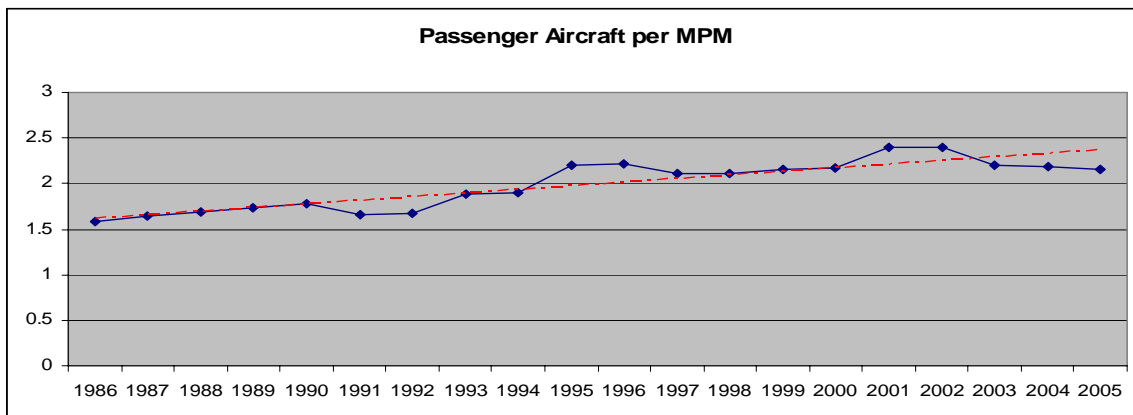


Figure 10. CRAF Passenger Aircraft per MPM/D Summary (HQ AMC Form 312 data)

### ***Cargo Fleet Gauge Trends Following Deregulation.***

Since the deregulation of cargo carriers in 1977, the cargo airlift industry has experienced a dramatic increase in capability. Total fleet capacity for CRAF cargo participants stood at 120 aircraft in 1980 with only 25 aircraft classified as wide body. In 2005, fleet statistics for CRAF participants had risen to 953 (down from a 1998 high of 1,007) with 491 wide body aircraft (see Figure 11).

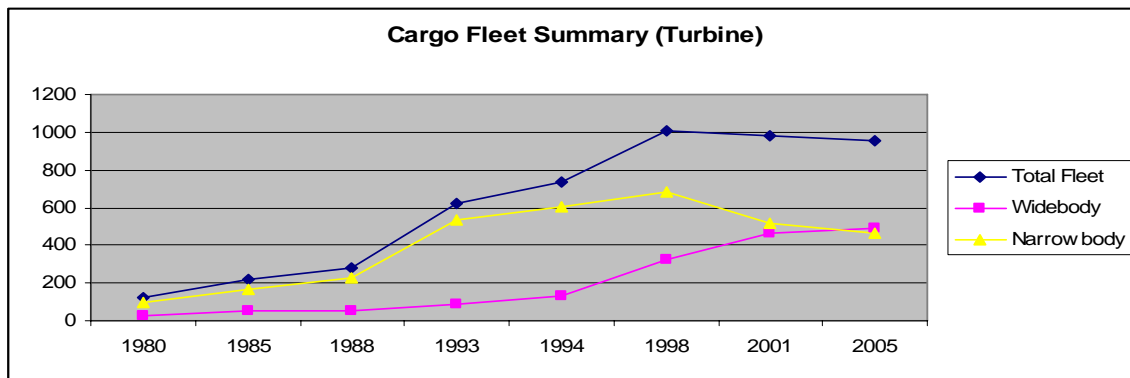


Figure 11. Cargo Fleet Summary 1980-2005 (ATA & ATW data)

Unlike their passenger counterparts, cargo carriers have continued their acquisition of wide body aircraft throughout the period of study. Although passenger carriers have continued to acquire newer, more fuel efficient twin engine wide body aircraft during the study period, the net result has been largely a static number of passenger wide body aircraft since 1993. The cargo carriers, on the other hand, have demonstrated the willingness to convert surplus passenger aircraft, both wide body and narrow body, to accommodate freight. Due in large part to the impressive growth of both the hub and spoke small package operations of FedEx, UPS, and Airborne/DHL, as well as the proliferation of smaller carriers with increased international capabilities, cargo



carriers have absorbed many of these surplus wide body aircraft for cargo use (see Figure 12).

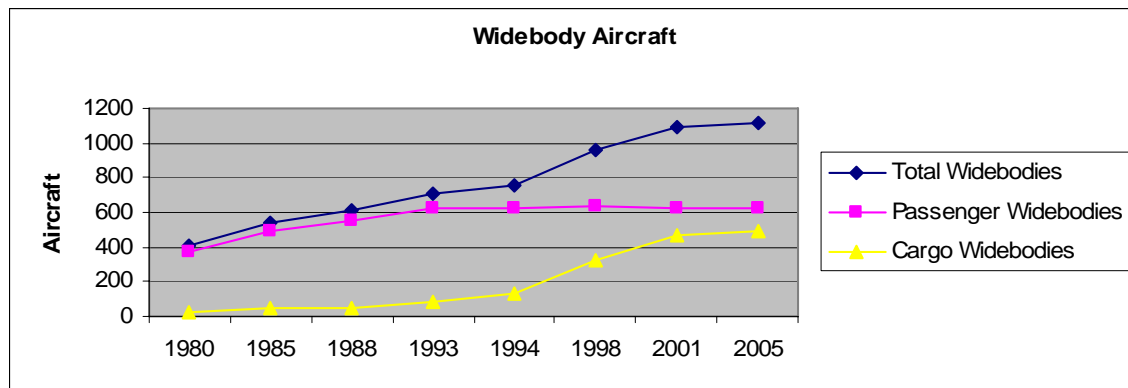


Figure 12. Wide-Body Aircraft Fleet Summary 1980-2005 (ATA & ATW data)

As an example of the shifting trend of three and four engine aircraft, the operation of the venerable Boeing 747 aircraft can be used as a case example. In Figure 13, the number of B-747 aircraft operated by U.S. carriers shows a fairly steady total inventory. However, a definite shift exists in terms of operators. There is a recent anomaly in the fleet summary data for cargo aircraft, though. The reduction in B-747 airframes in 2005 can be specifically attributed to the fleet reduction of Atlas Air Worldwide Holdings, which maintains operational control of both Atlas and Polar Air Cargo. These carriers had a combined reduction of 21 aircraft due largely in part to the carrier's merger of operations in 2002 and bankruptcy filing in 2004.

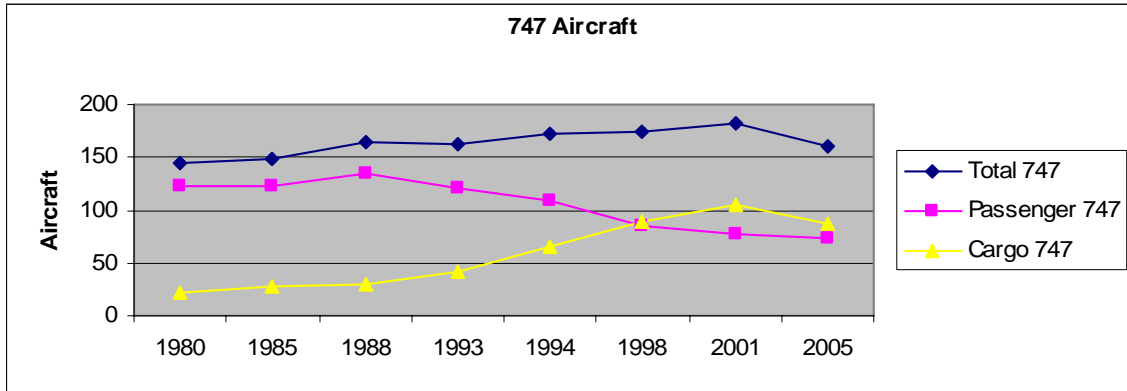


Figure 13. Boeing 747 Aircraft Fleet Summary 1980-2005 (ATA & ATW data)

Due to the simultaneous increase in both total fleet size and the use of wide body aircraft for cargo operations, CRAF long-range cargo operators have demonstrated a decrease in aircraft required per MTM/D (see Figure 14). For contingency planners, this is a positive development since fewer aircraft will be needed to haul the same tonnage of cargo in the event of contingency.

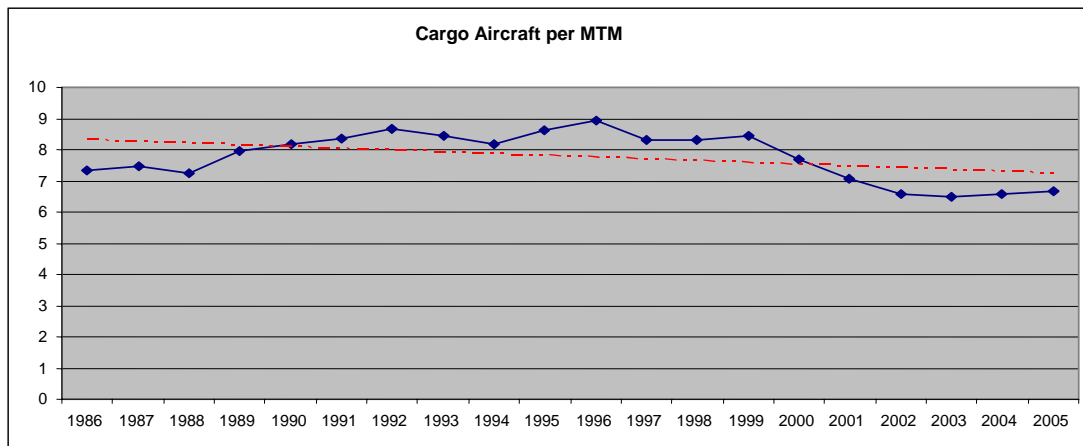


Figure 14. CRAF Cargo Aircraft per MTM/D Summary (HQ AMC Form 312 data)

This favorable trend of increasing gauge size for cargo carriers is likely to continue. According to FAA statistics, the reduction of three and four engine aircraft by

the passenger industry is predicted to be offset by growth of these aircraft in U.S. cargo fleets (see Figure 15) (Graham and others, 2003: 11).

Wide-Body Aircraft Type	Passenger		Cargo	
	2002	2010	2002	2010
4 Engine	92	77	68	116
3 Engine	92	32	183	245
2 Engine	477	642	206	454
Total	661	751	457	815

\* Note: The total U.S. passenger fleet in 2002 is 4913 aircraft and is projected to equal 7154 by 2010. The total 2002 U.S. cargo fleet is 1066 aircraft and is projected to equal 1362 by 2010.  
Source: FAA

Figure 15. Wide Body Aircraft Forecast 2002-2010 (Graham and others, 2003: 11)

Another positive trend of the cargo industry is the rise in new aircraft orders for cargo aircraft. Instead of acquiring used aircraft and converting them to carry cargo, the increased order rate of new cargo aircraft has risen significantly since 1990. The tremendous success of the Boeing 747 freighter, with 90 deliveries and continued orders, has prompted the company to offer a cargo variant of its 747-8 derivative under development as well as its current production lines of 767 and 777 aircraft (Boeing, 2006). Airbus Industries, Boeing's largest competitor, also offers freighter versions of its entire line of new production aircraft (Airbus Industries, 2006). Airbus' newest development, the A-380, designed to unseat the B-747 at the largest commercial aircraft in history, is also being designed with a freighter variant. Both FedEx and UPS each have ten firm orders for this new freighter aircraft (FedEx Express, 2005; UPS Signs, 2005).

## **V. Discussion**

### **The Commitment Dilemma**

The analysis of specific financial and non-financial fluctuations on CRAF capability provides several insights. First, the level of commitment by the carrier prior to the event inducing fluctuation is significant. Numerous airlines over the period of study began and ceased participation in CRAF with little effect due to the number of aircraft these carriers supplied. Although this point is fairly obvious, the balance of CRAF participation must then be analyzed. Using data from October 2005, the “big five” passenger airlines including American, Continental, Delta, Northwest, and United accounted for 56% of CRAF’s Stage I long range international passenger capability. When Stage III is examined, these carriers account for 88% of the dedicated aircraft. Thus, the demise or withdrawal of any of these carriers would have significant impact on CRAF capability. Even more damaging would be the withdrawal of multiple carriers. The same scenario holds true for long range international cargo operations.

Another factor which affects the impact of a carrier’s withdrawal from CRAF is the length of time the carrier takes to withdraw its aircraft from the program. As can be seen in the TWA example, the carrier gradually reduced its commitment over an extended period resulting in little fluctuation. The removal of Pan Am’s B-747 aircraft from the cargo segment, however, demonstrates the other extreme.

Finally, the economic period of the withdrawal must be considered. When either positive incentives or economic hardships encourage additional carriers to commit to CRAF, the impact of a carrier’s withdrawal from the program is minimized. Emery’s

withdrawal, as mentioned previously, was partially mitigated by the increased participation of Atlas/Polar in the long-range cargo segment.

In light of these factors, the following sections will focus on the issues surrounding the commitment levels of some of CRAF's largest participants.

***Cargo Air Carrier Commitment Concerns.***

The heavy reliance of CRAF cargo capabilities on FedEx has been a matter of interest since the mid-1990's (Daly, 1997: 39). Historical data contained in HQ AMC Form 312s since Desert Storm identify the consistent participation of FedEx in all levels of CRAF activation planning. During this period, FedEx has continually provided roughly one-third of the long range Stage III cargo fleet. More recently, the commitment level of FedEx has risen even further. The October 2005 HQ AMC Form 312 data reflects FedEx comprising more than 20% of Stage I & II capabilities and more than 43% of Stage III capability. At this commitment level, FedEx has volunteered 122 of its 251 wide-body aircraft for CRAF contingencies.

The motivation behind FedEx's large participation in the CRAF remains a private matter of the company's operating officers. However, an abrupt reduction of CRAF participation down to the minimum 15% must be considered as a contingency by mobility planners. If circumstances developed which prompted FedEx to reduce its commitment to the minimum 15% of its long range fleet, or 38 aircraft, the MTM/D would drop by 45.56-70.375 MTM/D depending on the types of aircraft withdrawn. This would reduce the cargo WBE commitment from 189% of required to roughly 130%. Although this level still exceeds the required WBE commitment level, the singular effect of one carrier on CRAF capability is impressive.

The remainder of the October 2005 long range cargo capability is divided in smaller increments among 13 other carriers with Atlas Air Worldwide Holdings, the parent company of Atlas International and Polar Air Cargo, providing the next largest commitment level of 39 aircraft. For Atlas, this level of commitment accounts for over 90% of the company's entire aircraft fleet according to current fleet statistics. Since Atlas and Polar are both heavily involved in the carter cargo business, the potential activation of such a large percentage of their fleets would not have as significant of an impact as that of a scheduled carrier, such as FedEx. However, both types of carriers would be compensated at the normal AMC rate during activation despite increased costs due to delays and routing restrictions (GAO, 1992: 9). In light of the large percentage of aircraft committed by both type of carriers, periods of activation may induce heavy financial burdens on carriers with high fleet commitments.

***Passenger Air Carrier Commitment Concerns.***

In the passenger CRAF, a similar scenario to FedEx exists with several airlines. According to October 2005 HQ AMC Form 312 data, American Airlines provided 182 long range wide body aircraft to CRAF passenger capability, 70% of American's wide-body fleet. When American's AE commitment of 58 B-767-300ER aircraft and 124 long range narrow body B-757-200ER aircraft are included in the calculations, American's commitment to CRAF jumps to 78 % of the airline's total long range capability. In terms of CRAF passenger capability, American Airlines aircraft accounted for 82.1 of CRAF's 277.64 WBE, or approximately 30%. If American reduced its commitment to the minimum participation level for GSA city pair participation, 30% of CRAF capable aircraft, it would remove 57 aircraft from the CRAF fleet. This would reduce the

committed WBE by approximately 30.5 to 41.2 WBE. This reduction would only reduce the committed WBE from 200% of required to 158%. However, other airlines also represent significant percentages of total CRAF capability.

In terms of WBE commitments, the second largest contributor to the CRAF program is United Airlines. According to October 2005 HQ AMC Form 312 data, United provides approximately 68.6 WBE to the long ranger passenger component.

Additionally, United commits 31 of the 51 B-747 aircraft committed to this segment of CRAF. United also provides 33 B-767-300ER aircraft to the AE component of CRAF accounting for another 19.77 WBE. 2005 was United's first year of participation in the AE segment and the carrier's inclusion bolstered the segment by 41% to a WBE capability of 57.27. Although United removed these B-767 aircraft from the long range international passenger segment based upon United's 2004 CRAF commitment, United substituted additional B-747-400 and B-777-200ER aircraft to the passenger segment to maintain its commitment level.

It is of interest that United's bankruptcy filing in 2002 has had no effect on its commitment to CRAF. In fact, during its time in bankruptcy, United CRAF participation rose by 30%. Prior to bankruptcy, United committed 77 of its 155 long range aircraft to CRAF, including 16 of its 44 B-747s. Three years later, as United prepared to exit bankruptcy, the carrier's commitment had risen to 83% of its long range fleet with 120 of its 144 long range aircraft and 31 of its 38 B-747 aircraft committed to CRAF.

If an event similar to the 1994 withdrawal by United and American occurred using the most current CRAF data, the October 2005 committed passenger WBE of

277.64 would be reduced by 54% to 126.8 WBE, below the 136 WBE needed by strategic planning scenarios.

### **Gauge Considerations**

Even prior to the events of September 11, 2001, the U.S. airline industry had begun to shift in operating perspective. Smaller carriers, termed Low Cost Carriers (LCC), fashioned largely after the Southwest model of a single aircraft type and efficient point-to-point service, experienced steady gains in revenue passenger miles (RPM's) prior to the attack. Following this event, however, the LCC model thrived while the traditional hub-and-spoke carriers languished.

Upon review of CRAF data, however, the necessity for the continued viability of the legacy carriers is obvious. Of the four CRAF segments which provide passenger support, only the Alaskan Section and Domestic Services Section are not dominated by the presence of legacy carriers. Even the Short Range International Section which accommodates the aircraft types typically used by LCC obtains a majority (55%) of its aircraft from legacy carriers. Since the requirement for B-767 aircraft is a prerequisite for participation in the AE Segment, that segment is comprised entirely of legacy carriers. Further, the aircraft included in the long-range international passenger section are overwhelming supplied by legacy carriers.

As previously mentioned, legacy carriers established hub airports to serve as consolidation points within their route networks in an effort to compete effectively with low cost startups in the 1980's. Hubs provided legacy carriers with three strategic advantages. First, it allowed for the servicing of less dense routes and incorporates these



passengers into to carrier's dominant network. Second, hubs allow the carriers to select appropriate gauge aircraft for both hub-spoke operations and hub to hub operations. Finally, the hub and spoke model provides legacy carriers with enough passenger density to their major destinations to maintain a high frequency level, a significant attribute for the legacy carriers' primary revenue source, business travelers (Levine, 2003: 43).

In order to efficiently operate these hub networks, the legacy carriers have focused on the acquisition of smaller gauge aircraft since deregulation. Modern twin engine narrow body and wide body aircraft are now the predominant aircraft types operating in both the domestic and international passenger airline system.

Although smaller gauge aircraft add efficiency to scheduled air carrier operations, the same does not hold true for military mobilization. In response to current trends in the passenger airline industry, General Baker, Vice Commander of Air Mobility Command commented on the reduced usefulness of smaller gauge aircraft due to their limited ability to move large numbers of troops as effectively as larger aircraft (Baker, 2004). Further, the use of smaller gauge aircraft poses several specific challenges to CRAF viability.

First, although the incremental increase of passenger aircraft required per unit MPM/D has been small during the period of study, the effect of increased aircraft in the airlift system can create unforeseen challenges. This is especially true in light of reduced foreign basing capability due to U.S. force withdrawal since the dissolution of the Soviet Union. For example, when comparing the MPM/D capability offered in Desert Storm (1.65 aircraft per MPM/D) to current trend data (2.25 aircraft per MPM/D), a 25% increase in aircraft sorties would be required to obtain the same passenger lift capability. In terms of aircraft count, a conflict requiring a 150 MPM/D capability would result in

248 sorties in 1991 and require 338 sorties using a MPM/D of 2.25, or 90 additional sorties. Although this example is theoretical, a similar scenario occurred during Operation Enduring Freedom. Due to the limited infrastructure and number of theater air bases, efficient sustained airlift was unachievable (Haulman, 2002: 3). As a result, the availability of airfields and sufficient infrastructure poses a more significant planning concern than that of total MPM/D (Bolkcom, 2005: 6).

Another problem reduced gauge size could create for passenger carriers involve crew requirements. As stipulated in AMCI 10-402, CRAF participants must provide a 4:1 ratio of crew per aircraft (AMC, 2004: 11). The CRAF instruction further requires that crews provided by CRAF carriers may not be members of the Air National Guard or Reserve forces to avoid any conflicts with activation (AMC, 2004: 11). However, civilian carrier may be faced with higher crew commitments due to gauge as well as the loss of crews due to Guard or Reserve service members. During Desert Storm, some airlines were forced to contend with the loss of up to 20% of its pilots due to military activation (Howard, 1996: 15). This factor partly contributed to American Airlines' temporary withdrawal from CRAF in 1993 (Howard, 1996: 15). In order to maintain the same MPM/D capability with smaller gauge aircraft, then, more crews would need to be allocated.

### **Airline Financial Challenges to Sustaining CRAF**

During the same period of growing reliance on CRAF by the military, the ramifications of industry deregulation have significantly affected the U.S. airline industry. In October 1978, President Jimmy Carter signed the Airline Deregulation Act into law thereby removing many of the government's controls on airline operations.

Since that time, the U.S. airline industry has experienced 163 airline bankruptcies with 143 of those bankruptcy filings resulting in the eventual cessation of operations of the airline either through consolidation or liquidation (GAO, 2005: 27). Further, since 2000, 23 airlines have filed for bankruptcy and the industry as a whole has experienced a loss of more than \$30 billion dollars (GAO, 2005: 6,8).

Other statistics are equally daunting. As of December 2005, twenty-four percent of the Stage III dedicated long range cargo aircraft were operated by carriers who had filed for bankruptcy protection since 2001. For the long-range international passenger segment, forty-six percent of the aircraft were offered by carriers operating in Chapter 11. Finally, the Aero-medical segment was dominated by bankrupt carriers with fifty-two percent of the committed aircraft being fielded by United and Delta. Furthermore, in a 2003 review of the Standard & Poor's and Moody's studies, the IDA determined that only 8% of the CRAF cargo fleet were vulnerable to financial default during the following five years while the passenger carriers showed more volatility with 18% at risk of default (Graham and others, 2003: 12).

## **Conclusions**

Due to its capability and cost savings for the Defense Department, the Civil Reserve Air Fleet will continue to maintain a critical role in defense planning. That being said, the industry which supports CRAF remains volatile. Although the financial crisis of September 11, 2001 is over four years past, the long term effects of this event are still affecting significant portions of the airline industry. Furthermore, the next economic fluctuation cannot be predicted. In light of these challenges, military planners must

remain cognizant of the financial conditions of participant airlines and the level of capability each carrier provides.

In addition to airline industry fluctuations, planners must also be aware of the impact gauge decisions by airlines will have on the military's ability to utilize these aircraft in times of activation. Due to reduced overseas basing opportunities and the likelihood that maximum aircraft on ground (MOG) will remain a limitation in future operations, the reduction in gauge size by passenger carriers must be accounted for in deployment planning. For CRAF cargo aircraft, though, future aircraft gauge is trending towards more lift capability per aircraft. This will assist planners in their effort to provide the war fighter with material and equipment in times of contingency.

### **Areas for Future Research**

While conducting research for this project, the issue of over-commitment in CRAF became a topic of interest. Since the incentive program was introduced in 1995, the level of passenger and cargo commitment has continually remained above mandated CRAF requirements. However, since the events of September 11 and the economic downturn that followed, CRAF commitments have reached unprecedented levels. According to HQ AMC Form 312 data published in October 2005, CRAF passenger commitments stood at 204% of required. For long range international cargo, commitments were 190% of required. Since carriers receive compensation in the form of Mobility Value Points, carriers providing excess capability are being awarded MV points despite the lack of planned need.

Furthermore, several research efforts have voiced the opinion that CRAF Stage III will never be activated under the current system. As a case in point, the increased volunteerism by the cargo airline industry in the spring of 1991 to avoid Stage III activation is an example of the extreme measures airlines will use to avoid Stage III activation. Therefore, compensating carriers for a non-existent risk is not prudent. Thus, three areas for research would be of interest.

1. Should a WBE limit be placed on Stage III to limit participants?
2. If no restriction is placed on Stage III, should the incentive program be modified to account for over-participation?
3. What is the likelihood of Stage III activation versus nationalization of the airline industry by the government in the time of national mobilization?

## Appendix A: Cargo Aircraft Mobilization Value (MV)

MV, which can be expressed in terms of million-ton-miles per day (MTM/D) or widebody equivalent (WBE), is a measure of the value DOD places on commercial aircraft for meeting wartime requirements and is based on the Payload (PL) capability, Block Speed (BS), and productive utilization rate (PUR), all of which are described below.

- "PL" is the weight of cargo, in short-tons, an aircraft can carry a specified distance, which is determined by using a range/payload chart to identify payload capability at the required distance.

- "BS" is calculated using the average true airspeed of an aircraft for the required distance (including climb-out and let-down) plus 20 minutes for block-out, taxi, and block-in.

- "PUR" is the actual rate at which an aircraft is fully productive. The minimum daily utilization rate of 10 hours per day required for acceptance into CRAF, when multiplied by the airlift productivity factor of 0.47, results in a productive utilization rate of 4.7 hours. See AF Pamphlet 10-1403

- "MTM/D" =  $PL \times BS \times PUR / 1,000,000$ . Base Cargo Aircraft MTM = 0.1705.

- "Base Aircraft" is the B747-100, a widebody (WB) aircraft, used for calculating all CRAF aircraft capability.

- "WB equivalent (WBE)" is the capability of an aircraft in relationship to the Base Aircraft. It is computed by dividing the MTM of the aircraft in question by the MTM of the Base Aircraft.

### MV CALCULATIONS

To determine MV, first calculate MTM/D and then calculate WBE.

$\frac{PL \times BS \times PUR}{1,000,000} = \text{MTM/D}$	$\frac{\text{MTM/D of Aircraft in Question}}{\text{Base Aircraft MTM/D}} = \text{WBE}$
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### CONVERT WBE (as MV) TO POINTS

- Aircraft WBE x 10\* = MV points (MVP)

### ADJUSTMENTS TO MV POINTS

Before aircraft are placed in CRAF Stages, MVP can be affected by extended long-range capability, short-field takeoff/landing capability, aircraft operations into austere locations, or anything that enhances aircraft capability, total capability the carrier offers to CRAF, and overall airlift augmentation capability CRAF provides to DOD. \

NOTE: \* A multiplier of 10 is used to achieve whole numbers.

(AMC/A34B, 2005)

## Appendix B: Passenger Aircraft Mobilization Value (MV)

MV, which can be expressed in terms of million-ton-miles per day (MPM/D) or widebody equivalent (WBE), is a measure of the value DOD places on commercial aircraft for meeting wartime requirements and is based on the Payload (PL) capability, Block Speed (BS), and productive utilization rate (PUR), all of which are described below.

- "PL" is the total combined weight of passengers and baggage an aircraft can carry a specified distance, which is determined by using a range/payload chart to identify payload capability at the required distance.

- "BS" is calculated using the average true airspeed of an aircraft for the required distance (including climb-out and let-down) plus 20 minutes for block-out, taxi, and block-in.

- "PUR" is the actual rate at which an aircraft is fully productive. The minimum daily utilization rate of 10 hours per day required for acceptance into CRAF, when multiplied by the airlift productivity factor of 0.47, results in a productive utilization rate of 4.7 hours. See AF Pamphlet 10-1403

- "MPM/D" =  $PL \times BS \times PUR / 1,000,000$ . Base Passenger Aircraft MPM = 0.71029

- "Base Aircraft" is the B747-100, a widebody (WB) aircraft, used for calculating all CRAF aircraft capability.

- "WB equivalent (WBE)" is the capability of an aircraft in relationship to the Base Aircraft. It is computed by dividing the MPM of the aircraft in question by the MPM of the Base Aircraft.

### MV CALCULATIONS

To determine MV, first calculate MPM/D and then calculate WBE.

$\frac{PL \times BS \times PUR}{1,000,000} = \text{MPM/D}$	$\frac{\text{MPM/D of Aircraft in Question}}{\text{Base Aircraft MPM/D}} = \text{WBE}$
--	--

### CONVERT WBE (as MV) TO POINTS

- Aircraft WBE x 10\* = MV points (MVP)

### ADJUSTMENTS TO MV POINTS

Before aircraft are placed in CRAF Stages, MVP can be affected by extended long-range capability, short-field takeoff/landing capability, aircraft operations into austere locations, or anything that enhances aircraft capability, total capability the carrier offers to CRAF, and overall airlift augmentation capability CRAF provides to DOD.

NOTE: \* A multiplier of 10 is used to achieve whole numbers.

(AMC/A34B, 2005)

## Appendix C: Bibliography of Sources Concerning the Incentive Program

- Kyrovac, Rob A. *Civil Reserve Air Fleet: A Rough Road Ahead*. Naval War College, Newport RI, 18 May 2004 (ADA 427666).
- Coffey, Rojer K., Frola, Ronald F., "The Civil Reserve Air Fleet: Trends and Selected Issues." Logistics Management Institute, Mc Clean VA, May 1996 (ADA 313220).
- Daly, John D. *Air Transportation: Elements of a Changing Environment and What It Means to the Civil Reserve Air Fleet*. Industrial College of the Armed Forces, Washington DC, 1997 (ADA331472).
- Evans, Carl. *Maintaining Civil Reserve Air Fleet Participation*, Naval War College, Newport, RI, 22 February 1993 (ADA 264149).
- General Accounting Office. *Military Airlift: Observations on the Civil Reserve Air Fleet Program*. GAO/NSIAD-96-125. Washington DC: GAO, March 1996.
- General Accounting Office. *Military Readiness: Civil Reserve Air Fleet Can Respond as Planned, but Incentives May Need Revamping*. GAO-03-278. Washington DC: GAO, December 2002.
- Graham, David and others. *Sustaining the Civil Reserve Air Fleet (CRAF) Program*. Institute for Defense Analysis, Alexandria VA, 1 May 2003 (ADA 431033).
- Schauber, Donald M., Jr. *Maintaining the Civil Reserve Air Fleet*. Naval War College, Newport RI, 8 February 2000 (ADA 378607).
- Wales, William S. *Civil Reserve Air Fleet Enhancement Program: A Study of its Viability in Today's Environment*. MS thesis. Naval Postgraduate School, Monterey CA, 1 March 1998 (ADA 343634).



## Bibliography

- Adams, Marilyn. "Has United Changed Enough," *USA Today*, 1 February 2006, sec. B:1.
- Allen, Mike, and White, Josh. "President Outlines Overseas Troop Cut," *The Washington Post*, 17 August 2004, sec. A:1.
- Airbus Industries. *Aircraft Families*. Company Website. 1 February 2006.  
<http://www.airbus.com/en/aircraftfamilies/acj/>
- Air Mobility Command. *Civil Reserve Air Fleet (CRAF)*. AMCI 10-402. Washington DC: HQ AMC, 1 September 2004.
- Air Mobility Command Public Affairs Office. "Fact Sheet-Civil Reserve Air Fleet." N. pag. 10 October 2005 <http://www.af.mil/factsheets/factsheet.asp>
- Air Transport Association of America. "U.S. Airline Bankruptcies, an Unofficial Compilation," n. pag. 15 January 2006.  
<http://www.airlines.org/econ/d.aspx?nid=6207>
- Air Transport Association of America. *The Annual Report of the U.S. Scheduled Airline Industry*. Washington D.C.: Air Transport Association of America. June 1979.
- Air Transport Association of America. *The Annual Report of the U.S. Scheduled Airline Industry*. Washington D.C.: Air Transport Association of America. June 1989.
- "AMR Corp.: Justice Department to Allow American Air-TWA Merger," *The Wall Street Journal*, 19 March 2001, sec. B:11.
- Baker, John R., Vice Commander, Air Mobility Command. "Supporting Joint Operations: Getting There," Air & Space Conference 2004, Washington DC. 13 September 2004.
- Barr, James A. *Impact of Insufficient Inter-Theater Airlift Assets on National Strategic Decision-Makers*. MS thesis, U.S. Army War College, Carlisle Barracks PA, 3 May 2004 (ADA 423640).
- The Boeing Company. *Orders and Deliveries Summary*. Company Website. 16 January 2006. <http://active.boeing.com/commercial/orders/index.cfm>
- Bolkcom, Christopher. "Strategic Airlift Modernization: Background, Issues, and Options," CRS Report for Congress, Washington DC, 25 March 2005.

- Brewer, Edward S. *A Commercial Solution to the Intertheater Airlift Shortfall*. MA thesis, ATZL-SWD-GD. U.S. Army Command and General Staff College, Fort Leavenworth KS, 17 June 2004 (ADA 428763).
- Carey, Susan and McCartney, Scott. "Long Flight: How Airlines Resisted Change for 25 Years, and Finally Lost," *The Wall Street Journal*, 5 October 2004, sec. A.1.
- Coffey, Rojer K., Frola, Ronald F., "The Civil Reserve Air Fleet: Trends and Selected Issues." Logistics Management Institute, Mc Clean VA, May 1996 (ADA 313220).
- Congressional Budget Office. *Options for Strategic Airlift*. Washington DC: Congressional Budget Office, October 1995.
- Congressional Budget Office. *Moving U.S. Forces: Options for Strategic Mobility*. Washington DC: Congressional Budget Office, February 1997.
- Daly, John D. *Air Transportation: Elements of a Changing Environment and What It Means to the Civil Reserve Air Fleet*. Industrial College of the Armed Forces, Washington DC, 1997 (ADA331472).
- Department of the Air Force. *Air Mobility Master Plan*. Washington DC: Department of Defense, 1998.
- Department of the Air Force. *Air Mobility Operations*. AFDD 2-6. Washington DC: HQ USAF, 25 June 1999.
- Department of the Air Force. *Organization and Employment of Aerospace Power*. AFDD 2. Washington DC: HQ USAF, 17 February 2000.
- Department of Defense. *Joint Doctrine for Mobilization Planning*. Joint Publication 4-05. Washington DC: GPO, 22 June 1995.
- Donovan, Pamela S. *The Value of the Civil Reserve Air Fleet: How Much Could the DOD Spend on Incentives*. MS Thesis, AFIT/GTM/LAL/96S-4. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 1 September 1996 (ADA 324940).
- Dudney, Robert S. "The Mobility Edge." *Air Force Magazine*, 86: 2 (August 2003).
- Evans, Carl. *Maintaining Civil Reserve Air Fleet Participation*, Naval War College, Newport, RI, 22 February 1993 (ADA 264149).
- "FedEx Express First to Take Delivery of Airbus A380 Freighter." Untitled press release, January 2005. 16 January 2006  
<http://www.fedex.com/us/about/today/companies/express/a380.html?link=4>

- Fricano, Michael. *The Evolution of Airlift Doctrine and Organization*. AU/AWC/RWP095/96-04. Air War College, Maxwell AFB, AL, 1 April 1996 (ADA 394005).
- General Accounting Office. *Changes Underway to Ensure Continued Success of Civil Reserve Air Fleet*. GAO/NSIAD-93-12. Washington DC: GAO 31 December 1992.
- General Accounting Office. *Military Airlift: Observations on the Civil Reserve Air Fleet Program*. GAO/NSIAD-96-125. Washington DC: GAO, March 1996.
- General Accounting Office. *Observations on the Civil Reserve Air Fleet Program*. GAO/NSIAD-96-125. Washington DC: GAO 29 March 1996.
- General Accounting Office. *Air Transport Capability Falls Short of Requirements*. GAO/NSIAD-00-135. Washington DC: GAO 22 June 2000.
- General Accounting Office. *Updated Readiness of U.S. Air Transport Capability*. GAO-01-495R. Washington DC: GAO 16 March 2001.
- General Accounting Office. *Military Readiness: Civil Reserve Air Fleet Can Respond as Planned, but Incentives May Need Revamping*. GAO-03-278. Washington DC: GAO, December 2002.
- General Accounting Office. *Bankruptcy and Pension Problems Are Symptoms of Underlying Structural Issues*. GAO-05-945. Washington DC: GAO September 2005.
- Graham, David and others. *Sustaining the Civil Reserve Air Fleet (CRAF) Program*. Institute for Defense Analysis, Alexandria VA, 1 May 2003 (ADA 431033).
- Handy, John W., "State of the Command," Address to the House Armed Services Committee United States House of Representatives Subcommittee on Projection Forces. Washington DC. 17 March 2004.
- Haulman, Daniel L. "Intertheater Airlift Challenges of Operation Enduring Freedom." Air Force Historical Research Agency, Maxwell AFB AL, 14 November 2002 (ADA 434031).
- Howard, Marc S. *Civil Reserve Air Fleet (CRAF)- Do We Still Need It?* U.S. Army War College, Carlisle Barracks, 19 March 1996 (ADA 308625).
- Johnson, Tom and Kim Kahn. "AMR Takes TWA Aboard," *CNN Money*, 10 January 2001. [http://money.cnn.com/2001/01/10/deals/amr\\_twa/](http://money.cnn.com/2001/01/10/deals/amr_twa/)

- Joint Chiefs of Staff. *Mobility Requirements Study 2005*. Washington D.C.: U.S. Joint Chiefs of Staff, November 2000.
- Levine, Michael E. "Crunch Time for Legacy Carriers," *Air Finance Journal*. 14: 40-45 (July 2003).
- Lewis, Ira. "The Civil Reserve Air Fleet: Balancing Risks and Incentives," *Transportation Journal*, 38: 32-40 (Winter 1998).
- Mach, Cheryl A. *Asymmetric Warfare-Can the Civil Reserve Air Fleet Meet the Challenge?* U.S. Army War College, Carlisle Barracks PA, 1 April 2001 (ADA 391137).
- Maynard, Micheline. "Pentagon's War Needs Are a Lifeline for Airline," *The New York Times*, 26 December 2003, sec B:1.
- Mullin, Leo F., Chairman and CEO Delta Air Lines. "Testimony of the Sir Transport Association on the Financial Condition of the Airline Industry." Testimony before the U.S. House of Representatives Committee on Transportation and Infrastructure. Washington DC. 19 September 2001.
- Priddy, Ronald N. *A History of The Civil Reserve Air Fleet in Operations Desert Shield, Desert Storm, and Desert Sortie*. Cambridge, MA: Arthur D. Little Inc., 1993.
- Reagan, Ronald. President of the United States. *National Security Decision Directive Number 280: National Airlift Policy*. Washington D.C.: The White House, 24 June 1987.
- Reed, Tim S. "Air Mobility: Simultaneous Enhancement of Airpower Legitimacy and Security Dilemma Amelioration," *Air Force Journal of Logistics*, 26: 24-32 (Spring 2002).
- Reese, David L. *Commercial Airlift Augmentation: An Organizational Study*. Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 1 June 2001 (ADA 430860).
- Reginold, Lester. "CRAF a 'Qualified' Success," *Air Transport World*, 28: 24-28 (August 1991).
- Robertson, Charles T. Jr., Commander-in-Chief, United States Transportation Command. "Strategic Airlift and Sealift Imperatives for the 21<sup>st</sup> Century," Address to the Senate Armed Services Subcommittee. Washington DC. 26 April 2001.
- Segal, Dave and Russ Lynch. "Hawaiian Airlines Files for Bankruptcy Protection," *Honolulu Star Bulletin*, 21 March 2003, sec. A:1.

- Skertic, Mark. "ATA founder confident he can rebuild carrier," *Chicago Tribune*, 12 November 2004, sec. B:1.
- Siddiqi, Asif. "Pan American: The History of America's "Chosen Instrument" for Overseas Air Transport," The United States Centennial of Flight Commission. Excerpt from unpublished article. n. pag. 16 November 2005  
[http://www.centennialofflight.gov/essay/Commercial\\_Aviation/Pan\\_Am/Tran12.htm](http://www.centennialofflight.gov/essay/Commercial_Aviation/Pan_Am/Tran12.htm). 2000.
- Teagan, Shawn E. *CRAF 2002-An Analysis of CRAF Participation Since September 2001*. Graduate Research Project. AFIT/GMO/ENS/02E-12. Graduate School of Engineering and Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, 1 June 2002 (ADA 430872).
- Tellijohn, Andrew. "Sun Country seeks \$15M to fly again," *St Paul Business Journal*, 34: 1 (February 2002).
- Tirpack, John. "Airlift Moves Up and Out," *Air Force Magazine*, 79: 29-31 (February 1996).
- Tirpack, John. "The Squeeze on Air Mobility," *Air Force Magazine*, 86: 23-29 (July 2003).
- Tirpack, John. "The Airlift Gap," *Air Force Magazine*, 87: 34-39 (October 2004).
- United States Department of Defense. "Civil Reserve Air Fleet Stage I Activation Announced." Electronic Message No. 064-03, 8 February 2003.
- "UPS signs firm contract for A380." Untitled press release, December 2005. 16 January 2006  
[http://www.airbus.com/en/presscentre/pressreleases/pressreleases\\_items/12\\_13\\_05\\_UPS\\_A380.html](http://www.airbus.com/en/presscentre/pressreleases/pressreleases_items/12_13_05_UPS_A380.html)
- Wales, William S. *Civil Reserve Air Fleet Enhancement Program: A Study of its Viability in Today's Environment*. MS thesis. Naval Postgraduate School, Monterey CA, 1 March 1998 (ADA 343634).
- Webber, Michael. "Air Cargo Industry Waiting for Economy to Fly Again," *Washington Business Journal*, 39: 22-23 (31 May 2002)
- Wells, Alexander T. and John G. Wensveen. *Air Transportation: A Management Perspective*. Belmont: Thomson Learning, 2004

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14. ABSTRACT <p>Since deregulation, the Civil Reserve Air Fleet (CRAF) has undergone significant commitment fluctuations within its long-range international passenger, cargo, and Aero-medical segments. Some of the causes of these fluctuations include the cyclical economic cycles of the airline industry, activation of CRAF, and the impact of changing gauge usage by the CRAF carriers. This project attempts to address the impact these fluctuations have had on CRAF readiness in the period of 1986-2005. To do so, a review of the origins of CRAF as well as its critical role in Department of Defense planning is conducted. Following the review, an analysis of CRAF commitment data provided by AMC A34/B as well as commercial fleet summary data are used to discern trends of both commitment and gauge. The research indicates that economic fluctuations have had limited effect on CRAF commitment levels with regard to single carrier bankruptcy events. However, the extent of the impact is largely dependent on the level of commitment the carrier provides CRAF as well as the abruptness of the event. Additionally, the reduction of gauge in the passenger airline industry will be a cause for concern for defense planners when faced with limited airfield availability. However, cargo aircraft have increased relative gauge size during the period of study.</p>					
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